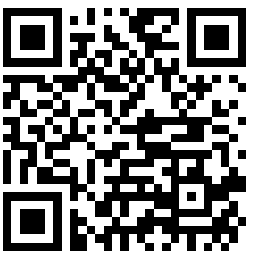

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DRAFT GUIDANCE FOR CRISIS RELOCATION PLANNING IN HIGHLY URBANIZED AREAS

THIS REPORT IS PART OF A SERIES OF DOCUMENTS WHICH PROVIDES BASIC PLANNING GUIDANCE AND RESOURCE DATA TO NUCLEAR CIVIL PROTECTION PLANNERS.

DEPARTMENT OF DEFENSE
DEFENSE CIVIL PREPAREDNESS AGENCY

CPG-2-8-17

DRAFT GUIDANCE FOR CRISIS RELOCATION PLANNING IN HIGHLY URBANIZED AREAS

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CENTER FOR PLANNING AND RESEARCH, INC.

P R E F A C E

The text of this document appears substantially as presented to the Defense Civil Preparedness Agency by the contractor, the Center for Planning and Research, Inc. As a result of a review by DCPA Regional and Headquarters staff, a number of modifications have resulted. In order to maintain the integrity of the Contractor's original draft, however, these modifications appear as notes at the end of the appropriate chapter. Since many aspects of crisis relocation planning involve devising solutions to the unique problems posed by each risk and host area, we hope that this study will provide NCP planners with a range of possible solutions from which they can select those which best meet the planning requirements of their particular areas.

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1. INTRODUCTION

This guide is a supplement to Parts I and II of the DCPA Guide for Crisis Relocation Contingency Planning (CPG2-8-A and CPG2-8-B). It is intended for use by planning teams assigned to highly urbanized areas that include one or more very large population centers, and that have a very large fraction of the total population at risk.

Crisis relocation planning in highly urbanized areas presents a number of problems:

- Problems of travel distance and hosting capacity must be considered in detail in order to devise credible allocation of risk populations to appropriate host areas.
- Higher than average hosting ratios will often be required in order to avoid excessively long relocation distances.
- The capacities of highways leading from the larger risk areas are often not sufficient to permit relocation in less than three days, thus requiring the use of non-highway modes of transportation.
- Smaller outlying risk areas may compete with the larger risk areas for highways and for available hosting space.
- Fallout risk may preclude using a substantial number of counties as host areas.
- Relocation across State lines may be required.

The supplemental guidance addresses the above problems. As a rule of thumb, all of the above planning problems should be anticipated in any State or group of contiguous States that include one or more risk areas having populations of more than 1 million persons. A list of these large population centers is given below.

Atlanta, GA
Baltimore, MD
Boston, MA
Buffalo, NY
Chicago, IL
Cincinnati, OH
Cleveland, OH
Dallas, TX
Denver, CO
Detroit, MI
Houston, TX
Kansas City, MO
Los Angeles, CA
Miami, FL
Milwaukee, WI
Minneapolis-St. Paul, MN
New York-NE New Jersey
Philadelphia, PA
Pittsburgh, PA
St. Louis, MO
San Diego, CA
San Francisco, CA
San Jose, CA
Seattle, WA
Washington, DC

Some of the above planning problems may also be encountered in other States where a number of smaller urbanized areas are relatively close to one another. In such States, the planning team should follow those portions of the supplementary guidance that relate to the problems they encounter.

In order to develop an equitable allocation of risk area populations to appropriate host areas in highly urbanized areas, it will be essential for the planning teams to consider (1) the pattern of relocation flow that is dictated by the relative size and location of the several risk areas in the territory assigned to the planning team, (2) the configuration and capacity of available transportation systems, and (3) the potential hosting capacity of areas that are not at risk. The concepts of relocation flow, transportation capacity, and hosting capacity underlie the planning and analysis procedures contained herein. These concepts are discussed below.

Relocation Flow

In highly urbanized areas it will be necessary to base the allocation of risk populations to appropriate host areas on a concept of relocation flow. The basic idea is that the movement from risk areas to host areas will be dominated by the outward flow of the population from the large risk areas. This outward flow of population will engulf smaller outlying risk areas as they are encountered. Often the general pattern of relocation flow will be associated with a single dominant metropolitan center. In other cases the general pattern of relocation flow will be influenced by several metropolitan centers that are relatively close to one another.

A portion of the population relocated from the large cities will be essential workers who will need hosting space nearby so that they may commute to and from the risk area in order to maintain essential facilities and operate essential services. The remainder must relocate to more distant locations. The populations of smaller risk areas will also have to relocate in a direction away from the principal city. Each of the smaller risk areas must be allocated nearby hosting space sufficient for its essential workers, but most of the residents will be allocated hosting space in distant locations.

Transportation Capacity

As the population size of risk areas increases, the problems of analyzing transportation requirements and developing credible plans will increase in complexity and difficulty. For risk areas with populations of greater than about 1 million persons, crisis relocation planning will require more detailed analysis of the availability and capacity of transportation systems than is required

for risk areas with smaller populations. This is because of several factors that become increasingly important as the population size of a city increases:

- The percentage of households with one or more automobiles is usually lower in the larger cities--a larger percentage of the population will have to be moved by other modes of transportation.

- The larger populations to be moved are more likely to overtax the highway carrying capacity than would be the case in the smaller cities.

- Most large population centers are surrounded by smaller urbanized areas that are also risk areas--the outlying smaller risk areas located at varying distances from the major population center add substantially to the transportation problem by increasing the relocation distances for risk area populations in order to avoid excessively high hosting ratios.

- Most very large population centers are located along the coast or on major inland waterways. As a result, the direction of relocation flow is often restricted.

In combination, the above factors make it more difficult for large populations to be relocated within the assumed optimum three-day period, unless the necessary transportation has been provided by careful prior analysis and planning.

Transportation Needs

Transportation will be needed for relocating risk area populations to host areas, for accomplishing commuting of essential workers to and from the risk areas, for sustaining the population in the relocated mode, and finally for returning relocatees to the vacated areas. Planning teams in highly urbanized areas will be confronted by similar problems in planning transportation, although the specifics of the problems will vary from area to area.

Relocation poses the most difficult set of transportation problems in highly urbanized areas. Detailed advance planning is essential, because the six-hour period of official notice and the three-day target for relocation will leave little opportunity for improvisation. Transportation resources must be allocated and used with care. Availability of automobiles and highway capacity will often be low in relation to need, and substantial fractions of population will have to use other modes of transportation. Close control over relocation operations will be needed to avoid waste caused by underutilization of resources or by degradation

of performance through congestion. This guide focuses on transportation needs for relocation and on procedures for identifying the most suitable way of using all available transportation resources.

Commuting consists of daily round trips of a small fraction of the population (essential workers) between host areas and job sites. Commuting service can be provided with a fraction of the resources needed for relocation and will generally commence after relocation. Therefore, commuting will usually present smaller and fewer problems than relocation.

Supply transportation will be needed to sustain the relocated population and to prepare for the return operation. Supply transportation requirements can be viewed in two parts: (1) satisfaction of day to day consumption needs, and (2) buildup of inventories. Deliveries for day to day consumption are expected to impose relatively light burdens on available transportation resources.[2] Buildup of inventories includes filling the distribution channels, establishing reserves, and refueling vehicles for the return operation, and should be given high priority in planning because the interval between the end of relocation and the start of return may be brief, and because it will be desirable to begin the return operation as soon as possible.

Return will be conducted using the resources employed in relocation and can be eased by extending the time period of return to four or five days or longer. However, planning and control of return will present special problems not encountered in relocation. Ongoing studies and planning projects will provide a better understanding of these problems.

Transportation Resources

Three main groups of transportation systems are available for relocation: highway, rail, and air. Where water transportation is available, its use should also be considered, especially in cases where shortfalls of other transportation modes are apparent. Each system includes vehicles and facilities having widely varying capacities and other characteristics.

Hosting Capacity

In order to avoid excessively long relocation distances in highly urbanized areas, it will usually be necessary to base the allocation on hosting ratios that are higher than required in other less urbanized planning areas. The ability of a host county to provide housing for the relocatees appears to be the factor that determines whether or not a given hosting ratio is feasible. Prototype planning projects and research studies indicate that other aspects of hosting are manageable. For example, in locations where

a high hosting ratio is required, treatment or disposal of the increased sewage load may require expedient measures, but there is no evidence that this problem in itself would be a limiting factor.

The basic policy objective in crisis relocation planning is to house and care for the relocated risk area population in non-residential, non-farm facilities in the host area; that is, the policy is to avoid billeting relocatees in host area households. In this connection, planners should review the applicable parts of Chapter II and all of Chapter IV of the Part I Planning Guide, CPG2-8-A.

The host area surveys accomplished so far have identified, on the average, from 3-1/2 to 4 congregate care spaces for each resident in the host counties surveyed. In the host area surveys, a space is defined as 40 square feet of usable floor area--this corresponds to the current peacetime emergency housing standards. Thus, one can expect, on the average, 140 to 160 square feet of usable floor area per host county resident. However, not all of this space is likely to be available or suitable for housing the relocatees. Some of the space surveyed is in buildings that are not readily usable for housing (sewage treatment plants and the like). Other space is in buildings needed for other purposes (e.g., police stations and food stores). The experience to date suggests that only about two-thirds of the congregate care space identified in the host area surveys should be considered as being available for housing relocatees. Therefore, for planning purposes, one can assume, on the average, about 100 square feet of potentially usable housing space per capita in the host counties. Based on this assumption, hosting ratios can be expressed in terms of equivalent congregate care space allocation, as shown below:

Hosting Ratio	Equivalent Congregate Care Space Allocation
1	100 square feet
2	50
2.5	40
4	25
5	20
6	16
8	12.5
10	10

On this basis, a hosting ratio of 2.5 would conform to the emergency housing standard of 40 square feet per person. States that have an internal hosting ratio equal to or less than 2.5 can be expected to have excess hosting capacity overall. States with a greater hosting ratio must crowd relocatees into what is available by adopting a smaller space allotment, or must participate in an interstate or regional relocation plan, or both.

Perhaps the best experience by which to judge the practicality of congregate care space allocations of less than 40 square feet per person is the large number of civil defense shelter occupancy experiments. Many such experiments have been conducted in which men, women, and children have lived for up to two weeks in shelters having a space allocation of 10_3 square feet per person, the current DCPA fallout shelter criterion.[3] This space allocation is known to be adequate under circumstances in which the occupants had to remain in the shelter throughout the shelter stay. In the case of housing for relocatees, the conditions of use would be less extreme. Relocatees would generally use the space only for sleep and rest. They would be outside or at assigned tasks during daylight hours and would be fed elsewhere. Thus, any space allocation of 10 square feet or over would seem to be practicable. Hence, hosting ratios up to and including 10 can be considered, where necessary, to avoid excessively long travel distances.

On the other hand, hosting ratios should be kept as low as practicable throughout a State. Also, the hosting ratios in adjoining States should be about the same, if this could be accomplished by regional planning.

Summary of the Planning Process

As a first step the planning team should review all sections of Parts I and II of the Crisis Relocation Contingency Planning Guide to become familiar with the essential elements of the processes involved in delineating risk areas and assigning risk area populations to appropriate host counties. They should also familiarize themselves with the contents of the Standard Data Packages for Parts I and II and the Supplemental Data Package for use in highly urbanized areas. The contents of this Supplemental Data Package are indicated in Table 1. Planning teams should also make a preliminary study of the geography, the population distribution, and the major transportation networks serving the area.

There is no single, simple, straightforward approach to crisis relocation planning in highly urbanized areas. Generally the planning team will have to analyze the transportation and hosting problems in a series of steps that progressively lead to the most desirable allocation that is compatible with the general pattern of relocation flow. Each successive step in the planning process will define the relocation flow to a greater level of detail and will result in trial solutions to the transportation and hosting problems. These solutions should then be reviewed with appropriate State and local authorities to obtain needed policy guidance.

The analysis procedures use hand-computation techniques that require the use of a good hand-held electronic calculator. The procedures were derived during a study of the feasibility of crisis

Table 1

SUPPLEMENTAL DATA PACKAGE FOR HIGHLY URBANIZED AREAS

1. Computer printouts showing probable fallout dose at MCD level--selected pages for States of interest.

2. Bureau of Census Publication, City and County Data Book, 1972, selected pages from Table 2 that relate to States of interest.

3. Standard Mileage Guide published by Rand McNally and Company.

4. U.S. Department of Transportation, Federal Highway Administration, Highway Statistics, 1973.

5. Highway Capacity Manual, 1965, Highway Research Board, National Academy of Sciences, National Research Council.

6. Maps of State and Interstate highways and major secondary routes for States of interest.

7. Airport statistics for States of interest extracted from Federal Aviation Administration publications.

relocation in the Northeast Corridor and were employed by the research team to the level of detail necessary to determine feasibility. Example planning factors and example trial solutions that are drawn from the feasibility study are included in the guidance to illustrate the planning process. These examples should not be interpreted as representing preferred solutions. The planning team will have to exercise considerable judgment in applying the planning and analysis techniques to its area of concern. Detailed planning factors that are appropriate to the area will have to be developed, based on an in-depth study of the area and on consultations with appropriate State and local officials. At each stage of the planning process, considerable judgment will be required to derive the best available solutions to the problems encountered. Often it will be necessary to develop alternative trial solutions for review by appropriate State and local authorities.

Chapter 2 contains planning procedures that are appropriate for situations where a regional allocation--one not confined within the boundaries of a particular state--will be needed to avoid overtaxing the available hosting capacity of a state or to avoid excessively long relocation distances for risk areas having large populations.

Chapter 3 presents preliminary transportation analysis procedures. A preliminary transportation analysis is needed to develop an understanding of the dimensions of the transportation requirements, to confirm tentative regional boundaries, and to identify problems that will influence the practicability of subsequent allocations of risk area populations to appropriate host areas. The preliminary analysis focuses on the large risk areas because the outward movement from the large population centers will dominate the general pattern of relocation flow, and because it is in the large risk areas that transportation constraints will usually be more serious. Procedures are given for determining the numbers of persons that could be relocated by automobile and the numbers of persons that will require other modes of transportation. Typical planning factors for non-highway modes of transportation are also given.

Chapter 4 is concerned with defining planning areas that include a very large city and its associated hosting areas. The configuration of a planning area is determined by the pattern of relocation flow, transportation networks, and potential hosting capacities in comparison with hosting requirements. The chapter includes a general allocation procedure which is used to determine average and maximum relocation distances at a particular hosting ratio.

Chapter 5 is concerned with procedures for determining whether available highway networks and vehicles in combination with non-highway modes of transportation have sufficient capacity to relocate the population from large risk areas within the three-day period allowed by the relocation planning assumptions. This determination is made by a procedure called the cordon technique which is a simple, though inexact, way of determining available highway capacity. Guidance on measures to increase highway capacity is also given.

Chapter 6 presents methods of adjusting the risk and host populations defined by the computer printout. These procedures are appropriate in situations where reduced housing space allocations are necessary, where commuting or relocation distances are excessive, or where the assessment of transportation capacity indicates excessive time required to clear the city. Moreover, consideration of relative fallout risk can often lead to satisfactory allocations that will reduce the need for expedient shelter construction.

Chapter 7 is concerned with identifying the mix of highway and non-highway system components and traffic controls that will be most suitable in a given planning area. Transportation requirements, resources, and capacity constraints must be examined in detail for each of the general allocations being considered, before attempting a detailed allocation.

In Chapter 8 the preceding planning procedures are pulled together and employed as the basis for a detailed allocation. The detailed allocation procedures permit the risk population of each risk county to be assigned to specific host counties in such a way as to equalize highway travel distances among the various risk counties and to use the available transportation resources to the best advantage. The procedures can also be used to evaluate the consequences of various allocation policies.

Finally, Chapter 9 outlines the needs for a planning report that documents the planning process used by the planning team.

Notes to Chapter 1

1. Although relocation in three days or less is the national objective, a three-day relocation may not be attainable for all risk areas. Where this goal cannot be met, evacuation should be carried out as expeditiously as possible.

2. If "transportation resources" is meant to include drivers and related essential personnel, then "heavy," not "light" burdens will be placed on available transportation resources.

3. It must be kept in mind that the congregate care space allocation of 10 square feet per person (fallout shelter standard) might stretch the credibility and acceptance of crisis relocation as a feasible civil defense option. Planners should proceed carefully, therefore, in this area, resorting to a 10 square feet per person allocation only after all other measures have been exhausted.

2. DELINEATING THE PLANNING REGION

Concept of Planning Regions

The planning procedures given in this chapter are appropriate for situations where a regional allocation--one not confined within the boundaries of a particular State--will be needed to avoid overtaxing the available hosting capacity of a State or to avoid excessively long relocation distances for risk areas having large populations.

In theory, the Crisis Relocation Planning problems of the highly urbanized parts of the country cannot be resolved in an efficient and equitable manner without performing a nationwide allocation of the populations of all of the risk areas to the most appropriate host counties. Such an allocation would be very cumbersome to manage and difficult to understand--and the number of calculations involved would require the use of a major computing center. In practice, it has been found that the United States can be partitioned into planning regions and that regional allocations are more manageable and understandable--and can be performed by hand computation techniques. In many parts of the country, the appropriate planning region is the State and State-by-State planning can go forward, as envisioned in CPG-2-8-A. In the highly urbanized parts, however, it is necessary to identify and define the boundaries of interstate planning regions. By region, we do not mean an organizational echelon, such as the DCPA Region, but rather a set of contiguous States within which an overall allocation is to be performed. (Whenever it is necessary to refer to DCPA Regions, the word "Region" will be capitalized and preceded by the acronym DCPA.) However, it may be found that the boundaries of a DCPA Region are as suitable as any other boundaries to define the planning region and can be chosen for organizational simplicity.

Planning regions should be drawn, at least initially, to include entire States, even though only part of a particular State may actually be needed in a regional allocation. As planning data is developed and trial solutions performed, the boundaries of the tentative planning region can be modified to reflect the emerging results. Usually, it will be desirable to delay such modifications of boundaries until the preliminary transportation analysis has been made (Chapter 3) and the region has been subdivided into planning areas and one or more general allocations performed (Chapter 4).

To delineate reasonable planning regions, it is necessary to consider (1) relocation flow and travel distances from the larger risk areas and (2)potential hosting capacity in the surrounding territory.[1] The approach to defining reasonable planning regions consists of two interactive steps. First, an overview of the direction of relocation flow from the larger risk areas is developed and tentative regional boundaries are identified. Second, the dimensions of the hosting problem

throughout the tentative planning region are assessed in terms of the hosting ratios that would be required to accommodate the populations of all the risk areas within the tentative region.

Relocation Flow and Travel Distances

Even in the large risk areas, most of the risk population is expected to relocate by automobile. Because the usual range of an automobile on a full tank of gasoline is about 250 miles, it is desirable to limit highway relocation distances to 250 miles or less. However, for many of the larger risk areas, relocation distances over 250 miles may be necessary to avoid excessively high hosting ratios. As a first approximation, 250 highway miles may be considered as equivalent to 200 airline or straightline miles. Therefore, if one or more very large population centers are within about 200 air miles of the area assigned to the planning team, the following procedures should be used to select tentative regional boundaries for crisis relocation planning.

On a suitable map, such as the Bureau of the Census map of county boundaries for the United States:

a. Indicate the approximate center of each large risk area that is within about 200 miles of the area assigned to the planning team.

b. Draw a circle with a 200-mile radius from the approximate center of the risk area having the largest population. It is not necessary to use the precise risk population for this purpose. If there is doubt, use the ranking in column 202 of Table 4, Urbanized Areas, in the 1972 County and City Date Book (item 6 of the Part I data package).

c. If one or more other large risk areas fall within (or near) the circle, draw a 200-mile circle around these also. Determine if still other large risk areas fall within these secondary circles for which additional circles must be drawn. Do not concern yourself at this time with the existence of smaller risk areas within the circles.

d. As each circle is added to the map, interpret the map to identify contested and uncontested hosting areas and the likely direction of relocation flow from the large risk areas. Contested hosting areas are where circles overlap; uncontested areas are where they do not. At a later stage of planning, the region will be subdivided into planning areas along county lines within the contested areas. The uncontested parts indicate the likely relocation flow direction from the risk area at the origin of the circle.

e. Continue the process until an overview of the likely relocation flow pattern becomes apparent. Consult DCPA TR-82 to determine where blast risk and fallout risk (green) counties denied to hosting would influence the relocation flow.[2]

f. Identify the States that should be included in the tentative planning region if relocation distances are limited to about the 200-miles radius. Judgment is required at this point, but generally, states not included in substantial part within a hosting circle ought not to be included in the planning region.

Figure 1 shows the result in the Northeast Corridor where the process was begun by a circle around New York City. That circle encompasses Boston to the northeast and Philadelphia, Baltimore, and Washington, D.C. to the southwest. The circles for Boston and Washington were drawn next and encompassed additional territory. (Circles for Philadelphia and Baltimore did not need to be drawn as they generally fell within the circles previously drawn.)

On the basis of the three circles shown in Figure 1, it is apparent that the most likely relocation direction for Boston is to the north and for New York City to the northwest. For Washington the relocation direction is to the southwest into Virginia, rather than to the west, to avoid competing for hosting space with Pittsburgh as well as Baltimore, Philadelphia, and possibly northeast New Jersey. Under these circumstances, it appears that uncontested host areas are available for Pittsburgh in West Virginia and Western Pennsylvania, and for Buffalo in Western New York State. Therefore, the process is discontinued because the overall relocation flow pattern has become apparent. At this point, the risk maps in DCPA TR-82 are consulted to make sure that the uncontested areas are actually available for hosting, as they are in this case.

A tentative conclusion based on Figure 1 would be that the planning region could be confined to the 13 States making up DCPA Regions 1 and 2, because the circle around Washington, D.C. includes only a minor part of the State of North Carolina. This planning region happens to be that chosen for assessing the feasibility of crisis relocation in the northeastern part of the United States.

Considerable judgment must be exercised by the planning team in establishing the boundaries of appropriate planning regions. For example, in Figure 1 Pittsburgh is located along the 200-miles radius circle centered on Washington, D.C. If the process had been continued and a 200-mile circle drawn around Pittsburgh, the circle would encompass Cleveland, Detroit, and Cincinnati to the west, and soon the process would be west of the Mississippi River.

To gain an appreciation of the degree of judgment that is inherent in defining the tentative boundaries of the planning regions, we offer

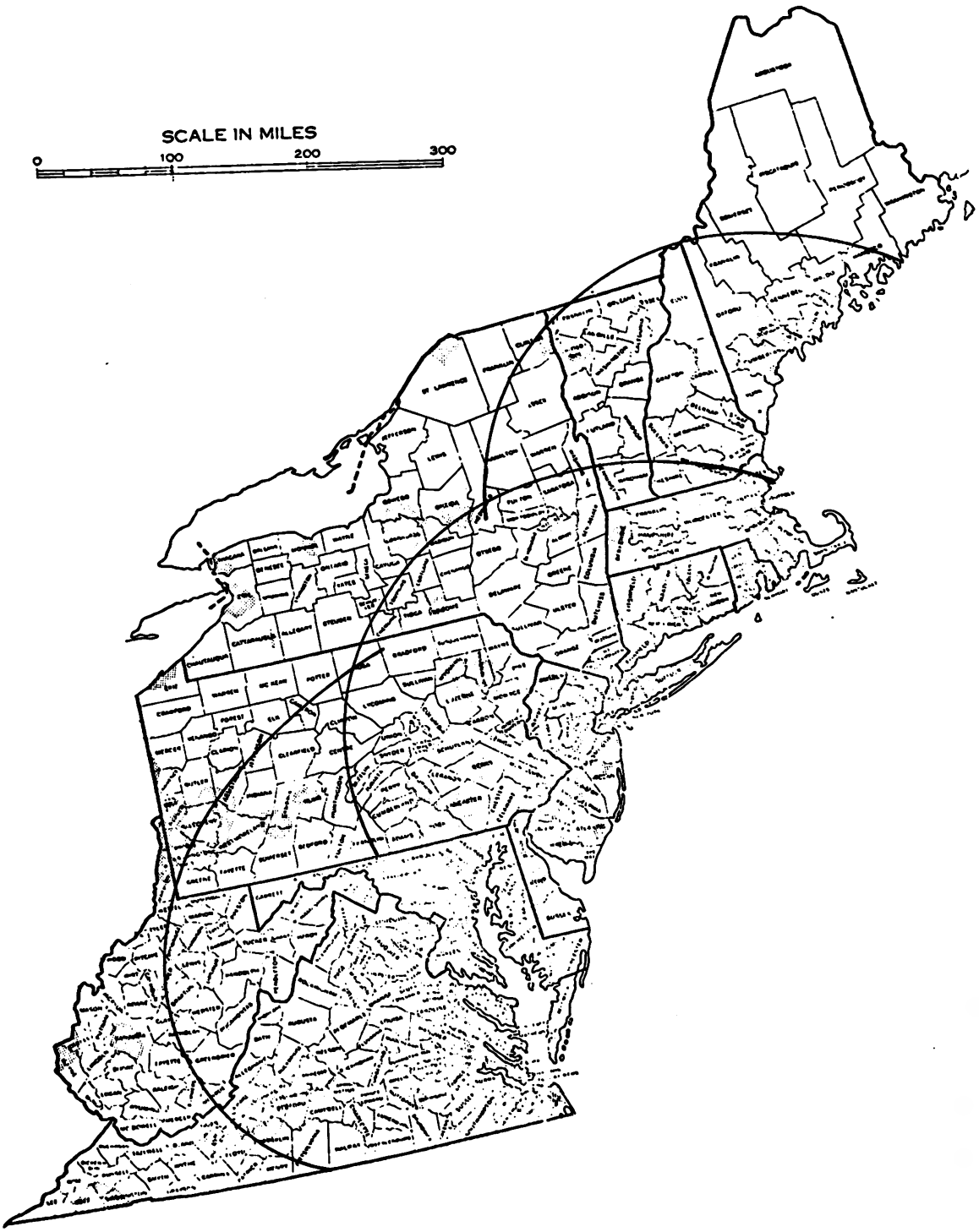

Figure 1 GEOGRAPHIC RELATIONSHIPS IN NORTHEASTERN CORRIDOR

a second example in which the above procedures are applied to another group of large risk areas. For example, in the midwestern United States a 200-mile circle around Chicago encompasses Milwaukee and is only a few miles short of Detroit and Cincinnati. St. Louis is somewhat farther away. If both Indiana and Michigan are included in a planning region along with Illinois and Wisconsin, Detroit would have to be considered. A circle around Detroit includes most of Ohio. Consideration of relocation flows for the Cincinnati risk area might involve Kentucky. The eastern portion of Iowa is within 150 miles of Chicago and should be considered at least initially. Finally, Missouri might also be included because of the interaction of St. Louis with southern Illinois. Minneapolis is too far west to interact with either Milwaukee or Chicago, and only a minor part of the State of Minnesota is within 200 miles of either. Hence, one might select initially the States of Illinois, Indiana, Iowa, Kentucky, Michigan, Missouri, Ohio, and Wisconsin as the planning region.

Reviewing the Hosting Situation

The second step required to place reasonable boundaries on a planning region is to review the hosting situation in the several States included in the tentative planning region identified by the above procedures. This review is made in terms of hosting ratios--the number of relocatees per host area resident--in each of the States and throughout the tentative planning region. Some changes in the tentative regional boundaries may be appropriate as a result of this review, especially if more states have been included than are strictly necessary.

On a suitable worksheet, such as shown in Table 2:

a. List the states of the tentative planning region in any convenient order.

b. Enter the total population of each State based on the 1970 Census.

c. List the risk and host populations for each State, either from the risk data on the computer printout provided in the data package, or from the information in TR-82.*

d. Calculate the hosting ratio in each State by dividing the risk population of each State by its host population.

e. Calculate the average hosting ratio throughout the planning region by dividing the total blast risk population of all the included States by the total host population of all the included States.

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*Detailed step by step procedures for obtaining these data from either the computer printout or DCPA Publication TR-82 are presented at the end of this chapter.

Table 2

RISK AND HOST POPULATIONS IN NORTHEASTERN PLANNING REGION

(Thousands)

State	Population	Risk Population		Host Population	Hosting Ratio
		Blast	Fallout		
DCPA Region 1					
Connecticut	3,032,217	2,710,652	235,725	85,840	31.58
Maine	992,048	329,494	None	662,529	0.50
Massachusetts	5,689,077	5,199,509	237,888	251,680	20.34
New Hampshire	737,681	319,957	81,195	336,529	0.95
New Jersey	7,030,306	6,490,144	395,019	145,143	44.72
New York	18,177,475	14,868,035	107,602	3,201,838	4.64
Rhode Island	949,723	912,276	37,447	None	∞
Vermont	444,732	83,093	None	361,639	0.23
DCPA Region 2					
Delaware	547,962	425,530	42,076	80,356	5.30
District of Columbia	756,510	756,510	None	None	∞
Maryland	3,918,471	3,344,361	274,089	300,021	11.15
Pennsylvania	11,774,961	8,136,736	289,040	3,349,185	2.43
Virginia	4,644,384	2,799,638	None	1,844,746	1.52
West Virginia	1,744,101	505,961	None	1,238,140	0.41
Area Totals	60,439,648	46,881,896	1,700,081	11,857,671	
Average Hosting Ratio					3.95

From Table 2 it can be seen that the hosting ratios vary widely among the 13 States in the Northeastern planning region. The hosting ratio is infinite in Rhode Island and the District of Columbia, as no part of these jurisdictions is available for hosting. At the other extreme, in Maine, New Hampshire, Vermont, and West Virginia, the residents of the host areas outnumber the residents of the risk areas, and hosting ratios of less than 1 (one relocatee per host area resident) would be required if there were no interstate movement of relocatees. Overall, the average hosting ratio for the entire planning region is about 4--i.e., about four relocatees for each host area resident--if the risk population is distributed uniformly throughout the host area. However, as previously shown in Figure 1, a uniform distribution of risk area population is neither feasible nor desirable because of the excesssively long relocation distances that would be required in using outlying portions of the planning region--Northern Maine, Western Virginia, and most of West Virginia.

Connecticut, Massachusetts, and Rhode Island all have higher than average hosting ratios, and as shown in Figure 1, the logical direction of relocation is to the north into Maine, Vermont, and New Hampshire where hosting ratios are much lower than the regional average. As shown previously, the likely relocation direction from the New York City risk area is to the northwest into upstate New York. Data in Table 2 indicate that the risk population in New York State could be hosted within the State at a hosting ratio that is only slightly higher than the regional average. New Jersey has a hosting ratio that is much higher than the average, and the New Jersey risk population would have to be accommodated in neighboring Pennsylvania, which has a lower than average hosting ratio. Again, this pattern of relocation is in accordance with the relocation flow shown previously in Figure 1. Finally, the relocation flow pattern from Maryland and the District of Columbia, each of which has excessively high hosting ratios, is to the southwest into Virginia and West Virginia where the hosting ratios are much lower than the regionwide average. Thus, one would conclude that, for the States listed in Table 2 and shown in Figure 1, a regional allocation is necessary and the listed States make up a reasonable planning region. A regional allocation would require hosting ratios of about 4, if the entire planning region were used. However, to avoid excessively long travel distances, it will not be feasible to use all of the potential host areas, and the effective hosting ratios will have to be higher than 4 in the parts of the region that are actually used for hosting.

In the Midwest example, as shown in Table 3, internal State hosting ratios are considerably lower than in the Northeast. Illinois has the highest ratio, 3.61. However, the counties in Southern Illinois, below St. Louis, are well over 250 highway miles from Chicago. Thus, a higher hosting ratio would be needed, perhaps 4 or more, to avoid excessively long relocation distances from Chicago. In the neighboring States of Wisconsin and Indiana, the hosting ratios are well below the regional

Table 3

RISK AND HOST POPULATIONS IN MIDWEST AREA

(Thousands)

State	Population	Population At Risk	Host Population	Hosting Ratio
DCPA Region 4				
Illinois	11,109.9	8,698.9	2,411.0	3.61
Indiana	5,193.7	2,949.1	2,244.6	1.31
Michigan	8,875.1	6,703.7	2,171.4	3.09
Ohio	10,651.8	7,698.1	2,953.7	2.61
Wisconsin	4,417.7	2,407.5	2,010.2	1.20
DCPA Region 3				
Kentucky	3,218.7	1,338.6	1,880.1	0.71
DCPA Region 6				
Iowa	2,824.4	975.0	1,849.4	0.53
Missouri	4,676.5	3,195.3	1,481.2	2.16
Area Totals	50,967.8	33,966.2	17,001.6	
Average Hosting Ratios				2.00

average of 2. Allocating some of the risk population from Illinois to these States could reduce the need for high hosting ratios in the vicinity of Chicago. Indiana could also serve to relieve some of the pressures for hosting space in Michigan where much of the state is more than 250 highway miles from Detroit and its surrounding cities. The internal hosting ratio in Ohio is somewhat above the eight-state regional average of 2 but about equal to the average hosting ratio in the five states making up DCPA Region 4.

In the Midwest example, there is considerable room for judgment regarding delineating planning regions. On the one hand, it could be argued that multistate regional allocation is unnecessary. Even Illinois could house its risk-area residents within reasonable distances at hosting ratios similar to those that will be required in the Northeastern States. On the other hand, consideration of relocation flow and the desirability of lower hosting ratios would argue for some interstate movement, particularly among the States in DCPA Region 4. If the five States of DCPA Region 4 are designated as a planning region, the average hosting ratio for the planning region would be about 2.4, about equal to the expected congregate care capacity at current standards. To avoid using the extreme parts of the DCPA Region--Southern Illinois, Northwestern Wisconsin, and the Upper Peninsula of Michigan--a hosting ratio of 3 or more would be needed but this would imply only a modest reduction in the space allocation. It would not appear to be necessary to include the neighboring States of Kentucky, Iowa, and Missouri in the planning region. Other alternatives could be considered. The planning team should identify and analyze several alternatives and make preliminary tentative allocations in accordance with the ensuing guidance.

For explanatory purposes, we assume here that it is decided to limit the planning region in the Midwestern United States to the five States of DCPA Region 4, as shown in Table 3.

Summary

The multi-State planning region obtained in the above manner will have appropriate dimensional characteristics for the large risk areas within it and will contain enough housing capacity for the gross risk populations involved, provided that a hosting ratio equal to or larger than the overall ratio determined above is adopted in the form of a modified housing space allocation, as discussed in the Introduction.

In this regard, adjacent planning regions may have differing requirements. In our two example regions, a hosting ratio of 4 or more is needed in the Northeast Corridor whereas a ratio of 3 may be sufficient in the Midwest (DCPA Region 4). This inequity at the Pennsylvania-Ohio border is of concern only in relocation planning for Pittsburgh, Wheeling, and other border risk areas. Ohio is simply too far away from

New York and Philadelphia to be of interest except by air lift. Thus, for the most part, the planning in the two regions can be accomplished separately, and adjustments can be made at the boundaries after the individual detailed allocations have been prepared for review.

Often, detailed allocation for an entire planning region is too cumbersome a procedure for hand calculation, and it is necessary to subdivide the region into suitable planning areas for allocation purposes. Preferably, there should be a planning area for each of the large risk areas in the planning region. Planning areas should be defined so that the hosting problems and travel distances are essentially the same among the planning areas. Before this planning step is undertaken, however, it will be useful to perform a preliminary transportation analysis for each of the large risk areas. it will be found that the preliminary analysis of the movement problem will provide important insights into the allocation problem.

ATTACHMENT TO CHAPTER 2 - PROCEDURES FOR OBTAINING RISK AND HOST POPULATIONS

Alternative 1. - Use of Computer Printouts

The total population of each state is taken directly from the 1970 Census. (Do not use update figures, as the computer printouts are based on 1970 information.) The data on fallout risk and host populations come from the computer printout "Disposition of Input Populations with Blast and Fallout," item 2 of the Part I data package and discussed on page 3-6 of CPG-2-8-A.

The last page of the printout for each State is a summary page (reproduced on the next page for convenience). The summary begins, "The non-urbanized area part of the population tape for (State) with code (XX) has just been read for the following." Mid-page will be found the following statement: "The total population used = (amount), of which (amount) are in cities to be evacuated, (amount) are not considered, and (amount) are in reception centers." The host population for the State is the final amount, pertaining to reception centers. Do not use any of the other amounts in this statement as they pertain only to the non-urbanized part of the population.

On the fourth line from the bottom of the summary page, the following statement will be found: "Counties to be evacuated from blast or fallout have evacuated population of (amount) of which (amount) were from blast." The fallout risk population in the State is the difference between these two amounts.

In Table 1, the blast risk population is obtained by subtracting the sum of the fallout risk and host populations from the total population. The ratio in the final column is obtained by dividing the blast risk population by the host population for each State. (Recall that the fallout risk population is neither evacuated nor used as hosts.)

Alternative 2. - Use of DCPA TR-82

If the computer printout is not readily available at this stage, a comparable worksheet can be developed from the information in DCPA TR-82. In this case, no distinction is made between blast risk and fallout risk. (The proportion at fallout risk is usually so small that the error introduced is acceptable at this stage of analysis.) The pertinent data are given for each State opposite the map.

- The column labeled "Total Population at Risk" should be summed for each urbanized and non-urbanized area and the total

THE NON-URBANIZED PART OF THE POPULATION TAPE FOR NEW YORK WITH CODE 36 HAS JUST BEEN READ FOR THE FOLLOWING

A TOTAL OF 106 NODES WERE READ OF WHICH 12 ARE CENTERS TO BE EVACUATED, 94 ARE RECEPTION CENTERS, 52 ARE RURAL, AND 0 ARE NOT USED

OF THE CENTERS TO BE EVACUATED 0 ARE CITIES, 3 ARE FROM WEAPON CLUSTERS, 9 ARE COUNTIES FROM FALLOUT, 0 ARE COUNTIES FROM BLAST

THE TOTAL POPULATION FEAD FROM THE INPUT TAPE IS 3962709

THE TOTAL POPULATION USED = 3963270, OF WHICH 761432 ARE IN CITIES TO BE EVACUATED, 0 ARE NOT CONSIDERED, AND 3201838 ARE IN RECEPTION CENTERS

OF THOSE IN RECEPTION CENTERS 1055206 ARE IN SMALL URBAN NODES AND 2146632 ARE RURAL

THE POPULATION NOT USED DUE TO BLAST RISK FROM OUTSIDE THE ZONE OF STUDY = 0

FROM BLAST RISK 562545 PEOPLE HAVE BEEN ADDED TO CITIES TO BE EVACUATED
COUNTIES TO BE EVACUATED FROM BLAST OR FALLOUT HAVE EVACUATED POPULATION OF 107602 OF WHICH 0 WERE FROM BLAST
EVACUATION NODES FROM WEAPON CLUSTERS HAVE A POPULATION OF 91285

POPULATION NOT USED DUE TO FALLOUT RISK = 0 ADDITIONAL NOT USED FROM BLAST RISK = 0 OF WHICH 0 ARE FROM WEAPON CLUSTERS

HOST POPULATION	3,201,838	
FALLOUT RISK POPULATION	107,602	
A	3,309,440	
TOTAL STATE POPULATION P	18,177,475	(from Census)
BLAST RISK POPULATION (P-A)	14,868,035	BLAST/HOST = 4.64

entered on the worksheet under a heading, "Risk Population."

- The risk population is subtracted from the total State population to obtain the total host population.

- The hosting ratio is then calculated.

Notes to Chapter 2

1. "Potential hosting capacity" includes mass feeding capability, adequate protective shelter, and health and medical capabilities.

2. TR-82 is adequate for determining blast and fallout risk areas only in a gross and general way.

3. PRELIMINARY TRANSPORTATION ANALYSIS

It is not possible to specify a single straightforward planning sequence that will meet the needs of planners in all highly urbanized areas. The several problems associated with crisis relocation planning are highly interdependent, and the solution of one problem will have a large influence on other problems. For example, the practicability of allocating risk area populations to appropriate host areas will depend on the availability, capacity, and appropriate utilization of transportation resources in each area.

The planning team will need to analyze the several aspects of the crisis relocation problem in a series of stages and iterative trials. Repeated trials will often be necessary, and the process will require the planners to exercise considerable judgement and to develop innovative solutions to problems, especially where transportation requirements may overtax the capacities of normally available transportation resources.

A preliminary analysis of the available transportation resources needed to relocate risk area residents should be performed to develop an understanding of the dimensions of the transportation requirements, to confirm tentative regional boundaries, and to identify problems that will influence the practicability of subsequent allocations of risk area populations to appropriate host areas. The preliminary analysis should focus on the large risk areas within a planning region, because transportation constraints will usually be more serious in the large risk areas, and because the outward movement from the large population centers will dominate the general pattern of relocation flow.

"First Autos" First

Automobiles, drivers, roads, and related resources constitute by far the most valuable and versatile system available for passenger movement and deserve first consideration in every risk area. The first step is to analyze relocation using a class of vehicles identified here as the "first auto" and defined as the best automobile available to the occupants of an individual dwelling unit having one or more automobiles. Planning teams should always give priority attention to first autos because: (1) they are a self-service mode of transportation; (2) they provide comfort, convenience, privacy, and security of possessions to travelers in a private vehicle; and (3) they do not have to be marshaled, manned, or managed in the same way as buses, trains, trucks, and aircraft. However, it will always be necessary to also consider other modes for two main reasons: (1) some people live in households that do not have autos, and (2) risk areas that have severely limited highway capacity may have to restrict use of some first autos to make room on the highways for buses and trucks carrying larger loads.

Determining the Availability of First Autos

In order to determine the availability of first autos as a resource to be used in relocating risk area populations, it is necessary to prepare a worksheet such as illustrated in Table 4. Separate worksheets should be prepared for all risk areas that approach or exceed a population size of 1 million within the tentative planning region. In preparing the worksheet, a column is provided for each county that is partially or totally within the blast risk area. If portions of two or more States are included in the blast risk area, each State should be identified, the county columns should be grouped, a column should be provided to total the data for the counties of each State, and a "Grand Total" column will be needed.

The procedures for using the worksheet to determine the availability of first autos in each county and through the risk area are outlined below:

a. The population of each county of the risk area is entered in line 1 using data from the ADAGIO printout for the State.

b. The blast risk population derived in accordance with procedures presented in the attachment to this chapter is entered in line 2 for each county.

c. The number of occupied housing units is determined from column 85 of Table 2 of the Bureau of the Census Publication County and City Data Book. An entry is made for each county.

d. The average number of persons per occupied housing unit is determined from column 86 of the same table and entered in line 4.

e. The percentage of occupied housing units that have one or more automobiles is determined from column 101 of the same table and is entered for each county.

f. The risk population of each county (line 2) is divided by the total population of the county, and the result is entered as a decimal fraction of the total population in line 6 for each county.

g. The number of occupied housing units in the blast risk area is determined by multiplying the entry in line 3 by the entry in line 6. Alternatively, the risk population is divided by the total population, and the result is multiplied by the number of occupied housing units.

h. The number of occupied housing units at risk with one or more automobiles is computed by multiplying the entry in line 7 by the entry in line 5. This entry indicated the number of households that can leave the area by first autos, if there is sufficient time and road capacity.

TABLE 4

AVAILABILITY AND CAPABILITY OF FIRST AUTOS - SAMPLE WORKSHEET

(Thousands)

Line	Item	Source	STATE NAME* First County Name**	Second County Name	.... Nth County Name	Total
1	County Population	Printout†				
2	Blast Risk Population	Printout†				
3	Occupied Housing Units	Col. 85 ††				
4	Persons per Occupied Housing Unit	Col. 86 ††				
5	Percent of Occupied Housing Units with One or More Autos	Col. 101††				
6	Risk Population as a Decimal Fraction of the Total Population	Line 2 ÷ Line 1				
7	Occupied Housing Units at Risk	Line 3 x Line 6				
8	Occupied Housing Units at Risk with Autos = First Autos	Line 7 x Line 5				
9	Persons in Risk Occupied Housing Units with Autos	Line 8 x Line 4				
10	Persons without Autos	Line 2 - Line 9				

*If parts of two or more states are in the risk area, provide space and columns for each.

**Enter name of each county. Use a column for each county in blast risk area.

†ADAGIO printout, item 2 of the Part I data package.

††U.S. Department of Commerce, Bureau of the Census, County and City Data Book, 1972, Table 2.

i. The number of persons at risk who are in occupied housing units with one or more automobiles is calculated by multiplying the entry in line 8 by the entry in line 4 for each county. This product is the number of people who can leave the area by first autos, if there is sufficient time and road capacity.

j. The number of persons at risk without access to a first auto is calculated by subtracting the entry in line 9 from the entry in line 2 and is entered for each county in line 10. This entry is the number of persons that must be moved by transportation modes other than first autos.

k. The entries for lines 2, 8, 9, and 10 are totalled across the columns for each State, and a grand total is calculated if the risk area contains portions of more than one State.

Assumptions for the above calculations are: every household regardless of size will move in its best automobile, and second automobiles will not be used; and housing units that have a small number of occupants will follow the same rule and not carry other people in their autos. These assumptions provide the planning team with the first indication of possible ways to increase the numbers of people that could be relocated by automobiles. For example, the crisis relocation (a) might include provisions for using second or third automobiles if there were sufficient highway capacity, or (b) might specify the minimum number of passengers that would have to be carried in order to allow an automobile access to outward bound highways if highway capacity were limited. Other options are discussed later.

During the feasibility study, the above procedures were applied to the major population centers in the Northeast Corridor. Table 5 shows the results that were obtained in the analysis of the nine-county New York City risk area. For example, in Kings County, NY, there are 1,054,400 persons in 363,600 housing units with at least one auto. Another 1,547,600 persons do not have access to first autos and will have to be moved by other modes. The "Total" column in Table 5 indicates the dimensions of the relocation problem using first autos for the entire risk area -- i.e., 6,554,000 persons (57.3%) could be moved by first autos, and another 4,885,900 persons (42.7%) without access to first autos would have to be moved ~~by other transportation~~ modes.

Preliminary Analysis of Transportation for the Carless

In risk areas where a very large number of people are carless, it will be necessary to consider all modes of transportation: rail, air, water, trucks, and buses as well as first autos. Also, in some cases it will be found that highway capacity is not sufficient to accommodate all first autos plus buses and trucks needed for the carless. Consequently, planners dealing with large risk areas should make a preliminary estimate of the capacity of non-highway modes--specifically railroads (passenger

TABLE 5

NEW YORK RISK AREA

Automobile Relocation
(Thousands)

Line	Item	Source	Bronx	Kings	Nassau	N.Y.	Queens	Rich-mond	Rock-land	Suf-folk	West-chester	Total
1	Population	Printout	1471.7	2602.0	1422.9	1539.2	1986.4	295.4	229.9	1110.6	889.2	11,547.3
2	Risk population	Printout	1471.7	2602.0	1422.9	1539.2	1986.4	295.4	226.4	1047.2	848.7	11,439.9
3	Occupied housing units	Col. 85	497.2	876.1	401.1	687.3	690.1	86.2	60.4	295.6	282.6	3,876.6
4	Persons per occupied housing unit	Col. 86	2.9	2.9	3.5	2.2	2.8	3.4	3.8	3.8	3.1	3.09
5	Percent of occupied housing units with one or more automobiles	Col. 101	37.6	41.5	91.7	21.5	63.6	80.1	90.8	93.1	82.6	
6	Risk population as a percent of the total population	Line 2 ÷ 1	100.0	100.0	100.0	100.0	100.0	100.0	98.5	94.3	95.4	
7	Occupied housing units at risk	Line 3x6	497.2	876.1	401.1	687.3	690.1	86.2	59.5	278.7	269.6	
8	Occupied housing units at risk w/ autos = #1 autos	Line 7x5	186.9	363.6	367.8	147.8	438.9	69.0	54.0	259.5	222.7	2,105.4
9	Persons in risk occupied housing units w/auto	Line 8x4	542.0	1054.4	1287.3	325.2	1228.9	234.6	205.2	986.0	690.4	6,554.0
10	Persons without autos	Line 2-9	929.7	1547.6	135.6	1214.0	757.5	60.8	21.2	61.2	158.3	4,885.9

and freight); commercial aircraft and airports, and water transportation, if available.

Relocation via rail, air, or water will generate feeder trips in risk areas and distribution trips in host areas. It is important to bear in mind that the transportation resources committed to feeder and distribution service will not be available for relocation service. Feeder trips should be supplied by buses, taxis, trucks, or other chauffeured vehicles rather than by private autos, in order to avoid overloading limited parking facilities and congesting access roads. Planning feeder trips will require specific attention. As part of this step, planners should estimate the maximum number of vehicles of each type that would be used for feeder services for each mode. Taxis and other small vehicles may be used for feeders rather than large buses. In host areas, school buses, trucks, and autos are expected to be available in sufficient numbers to provide distribution services from airports and rail terminals. This assumption should be verified in each case.

Railroads

Areas having large risk populations are all served by railroads that can be used for crisis relocation services. Planning teams can identify rail routes, suitable for crisis relocation, by consulting standard reference works or by interviewing local rail officials.

Passenger trains now operate on a few routes between risk and host areas. Most passenger trains are operated for Amtrak by the railroads but remain under the control of the railroad companies. Some railroads operate commuter services.

The following typical planning factors can be used to derive preliminary estimates of the relocation capacity of passenger trains, subject to correction at later planning stages:

- Trains contain 10 cars.
- Trains carry 1,500 passengers with crowding.
- Loading requires 60 minutes.
- Unloading requires 60 minutes.
- Trains average 40 miles per hour.
- Trains make round trips.
- Trains spend 20 hours per day in the duty cycle.

At later stages of the planning, planning teams should seek guidance and assistance from Amtrak and the railroads to refine their preliminary capacity estimates and to develop plans for using passenger trains, choosing routes, selecting loading and unloading points, and other measures needed to make best use of this resource.

Freight trains can be adapted to passenger service, but doing so will require significant effort by planning teams and railroad officials. The capacities of railroads to carry passengers in freight trains are not known with great confidence. The following planning factors can be used to derive preliminary estimates of the relocation capacity of freight trains:

- Trains contain 30 cars.
- Trains carry 1,500 passengers.
- Loading requires two hours.
- Unloading requires two hours.
- Average train speed is 40 miles per hour.
- Each route will carry 40 loaded trains per day.
- Freight trains will not make round trips unless there is a shortage of locomotives and cars.

During later stages of the planning, planning teams should seek the aid of railroad officials to develop planning factors that reflect local conditions. Routes must be selected, and loading and unloading points must be designated. The locations of loading and unloading points must be communicated to train crews, travelers, and agencies furnishing road transportation to and from trains. Railroad officials must plan to marshal locomotives and empty cars and to spot the equipment at designated loading points. Railroad officials must also plan to conduct a complex special passenger operation involving many locomotives, cars, and train crews, while maintaining other transportation services.

Air Transportation

Planning teams in areas containing large population centers are likely to find that commercial air transportation is a valuable resource for crisis relocation operations.[1] The Federal Aviation Administration publishes statistics for each commercial airport, indicating its annual number of aircraft operations and aircraft types. Airports in large population centers accommodate far more flights and larger aircraft than airports in outlying areas. Consequently, the capacity of air transpor-

tation is likely to be constrained by the availability of suitable airports in host areas.

Planning teams should first identify potentially usable airports of all types in host areas and in smaller outlying risk areas, and then determine their normal capacities. To make best use of these capacities, plans should be made to increase the capability of existing commercial airports, to convert some general aviation and idle airports (and perhaps some military airports) to emergency passenger service, and to airlift specialized personnel and equipment from other airports to airports in need of them. Substantial airlift of personnel and heavy equipment might be needed to accommodate large wide-body aircraft such as the B-747, L-1011, and DC-10 aircraft. Achieving large increases in airlift capacity would depend upon cooperation from a number of different agencies including airport owners (military or civilian), commercial airlines, and the military or commercial operators of cargo planes capable of delivering needed ground equipment. The Civil Aeronautics Board, War Air Service Program, publishes a WASP report listing all commercial aircraft by number of seats.

The following typical planning factors can be used to derive preliminary capacity estimates for air transportation:

- Small passenger aircraft carry 100 passengers normally seated.
- Large (wide-body) aircraft carry 300 passengers normally seated.
- Average trip is 250 miles.
- Average flight time is 40 minutes.
- Average ground delay is 30 minutes.
- Round trips average 2-1/3 hours.
- Aircraft average eight round trips per day.
- Small planes carry 800 passengers per day.
- Large planes carry 2400 passengers per day.
- A typical host airport can handle 120 flights per day.
- A typical host airport serving small aircraft averages 12,000 passengers per day or 36,000 passengers in a three-day period.
- A typical host airport serving large aircraft averages 36,000 passengers per day or 108,000 passengers in a 3-day period.

- It may be possible to increase all capacity factors cited above by 50% by carrying some passengers without seats and seatbelts.

Fuel consumed, flying hours, and crew requirements are not significantly greater than in normal commercial operations, and availability of these resources should not constrain capacity.

Water Modes

For many risk areas, modes of water transportation may provide high capacity, effective alternatives to other modes. In consultation with port authorities, Coast Guard, and owners or operators, the planning team will have to determine availability and capacity factors that are appropriate to their specific area. Planning to use water modes requires consideration of feeder service to the port, routing to destinations, and distribution from reception port to host facilities. In New York, it appears that at least 100,000 persons can be relocated by water.[2]

Examples

The following examples based on the preliminary capacity factors illustrate the potential utility of non-highway modes:

Example: Railroads

Two lines connect New York City with the northern host areas: Penn Central main lines to Albany and Schenectady, with lines from there to the north and west. Across the Hudson in New Jersey are two more rail lines that go to the New York host counties, a Penn Central line to Albany and an Erie Lackawanna to Binghamton, Elmira, and other cities to the west. it was estimated that 180,000 persons could be relocated via each line in a three-day period, or 720,000 persons in all.

Example: Air Transportation

There are three large commercial airports in the New York City area and five small commercial airports in New York host counties. In consequence, it is estimated that about 500,000 persons could depart the risk area in a three-day period.

Subsequent study in New York has shown that all non-highway modes probably have greater capacity than was recognized in the feasibility study.

The examples indicate that over 1.2 million carless persons could be moved by non-highway modes. Highways would need to remove the remainder: 6.6 million with access to first autos and 3.7 million in other vehicles--presumably buses and trucks.

It should be noted that the non-highway modes are constrained with regard to the places they can deliver people. Thus persons relocated by air should be hosted as near airports as possible. These aspects of transportation capacity should be considered throughout the allocation process.

ATTACHMENT TO CHAPTER 3 - INSTRUCTION FOR OBTAINING COUNTY RISK POPULATION

The risk population for the preliminary transportation analysis in Table 3 is drawn from the ADAGIO printout (item 2 of the Part I data package). The planners should revew the discussion of how to interpret the printout in Chapter 3 of CPG-2-9-A. The total population of the county is given at the top of the county listing as the first of four sets of numbers (T-U-R-UA). These populations should be entered in Line 1 of Table 3.

The basis for determining the blast risk population of a county will be found at the end of the listing of MCDs at risk in the county. If the risk county is also at fallout risk, as if often the case, the following statement will be found: "New Fallout Evacuated Node With Number XX Formed With Population xxxxxxxx." If the last number is zero, all of the county population is at blast risk. If it is not zero, the number should be subtracted from the total population of the county to obtain the blast risk population. The final line in the county listing will say, "Risk Reduced County Population Leaves No Final Reception Centers." This merely confirms that those not at blast risk are at fallout risk.

If the non-risk part of a risk county is not at fallout risk, there will be no "Fallout Evacuated Node" statement. The risk population is obtained by subtracting the "Risk Reduced County Reception Center Popn" on the bottom line from the county population. If there are two population values, rural and urban, they must both be subtracted from the county population to obtain the correct risk population. As before, if the final statement indicates no final reception centers, the entire county population is at blast risk.

Notes to Chapter 3

1. Planners must exercise caution in including air transportation as a resource in crisis relocation operations. Federal laws should be reviewed and statistical data gathered before any large-scale use of commercial aircraft is planned.

2. Utilization of private boats should also be considered by planners.

4. DEVELOPING PLANNING AREAS

Planning Areas

The preliminary transportation analysis discussed in Chapter 3 provides some insight into the dimensions of the "first auto" movement capability that constitutes a major load on the available highway system and indicates the potential capability for relocating carless persons by non-highway modes of transportation. Each large metropolitan area will be found to have its own mix of capabilities and needs. In order to evaluate transportation capacity constraints, it is necessary to subdivide the tentative planning region into suitable parts (planning areas) that can be analyzed conveniently and that associate the respective large cities with "their" hosting areas. As a rule of thumb, there should be a separate planning areas for each large risk area, although occasionally two large cities can be included in the same planning areas if there is sufficient uncontested hosting area.

Each planning area should be identified with the major city within it and will include other smaller risk areas as well. Thus, in the Northeastern planning region, five planning areas will be required--for Boston, New York, Philadelphia, Baltimore, and Washington, D.C. Separate planning areas for Pittsburgh and Buffalo are not needed because they are too remote to seriously compete for hosting space. They can be included in the planning areas for Philadelphia and New York at this stage of planning, although it may be desirable to create separate planning areas for them at a later time. In the Midwest planning region, if it is coterminous with DCPA Region 4, one should devise planning areas for Chicago, Cincinnati, Cleveland, Detroit, and Milwaukee.

Boundaries of the planning areas should follow county lines, because the data on risk and host populations are presented by county in the computer printouts. The boundaries of the planning areas will follow the State lines at the perimeter of the planning region, but generally need not follow State lines within the region unless it is convenient to do so. To the extent possible, the boundaries of the planning areas should be chosen so that the average and maximum relocation distances within each planning area are about the same as those in other planning areas, using a common hosting ratio throughout the planning region. Sometimes, as in the Northeastern planning region, the desired balance will not be achieved even after several trial solutions. Nevertheless, the balance can be successively improved until the planning team judges that further modification is unwarranted.

Assessing Geographic Relationships

The tentative boundaries selected for the planning areas should be based on the general geographic relationships of the host counties to the major city within the planning area, and on a consideration of the primary highway routes available. The tentative boundaries can then be modified after a trial solution has been performed.

The general procedures for assessing geographic relationships and delineating the boundaries of planning areas are listed below and discussed in subsequent paragraphs:

a. On a suitable map, draw straight lines connecting the large risk areas of the planning region.

b. Erect a perpendicular to the line at the midpoint between each pair of large risk areas. This will show graphically which parts of the hinterland are closest to one or the other city. See Figure 2, which is for the Northeastern region.

In Figure 2 it is seen that the northern part of New York State is closer to Boston than it is to New York. Also, the northeast corner of Pennsylvania is closer to New York than it is to Philadelphia. The perpendiculars to the south of Philadelphia are not shown, because the hosting capacity in this area is known to be ample and it is clear that relocatees from Washington must move south into Virginia, while those from Baltimore move west above Washington.

In the Midwestern example, a similar map exercise would show that southwestern Michigan and northern Indiana are most convenient to Chicago, whereas northwestern Ohio should be available to Detroit. In some cases, this simple procedure may be misleading. For example, the perpendicular drawn between Chicago and Milwaukee is approximately on the State boundary. However, as shown previously, there is no point to including Wisconsin in the regional allocation unless Chicago can obtain hosting space in southwestern Wisconsin. Hence, it is obvious that Milwaukee and its nearby Wisconsin risk areas must plan to move north and northwest rather than west or southwest.

Assessing Hosting Capacities

The second approach to identifying appropriate boundaries for planning areas is based on the considerations of hosting capacity discussed in the Introduction. It will be recalled that a hosting ratio of 2.5 relocatees per host is equivalent to a congregate-care space allocation of 40 square feet per person (the peacetime emergency housing standard) and that higher hosting ratios, up to 10, are feasible at reduced housing space allocations.[1] To assess the implications of a parti-

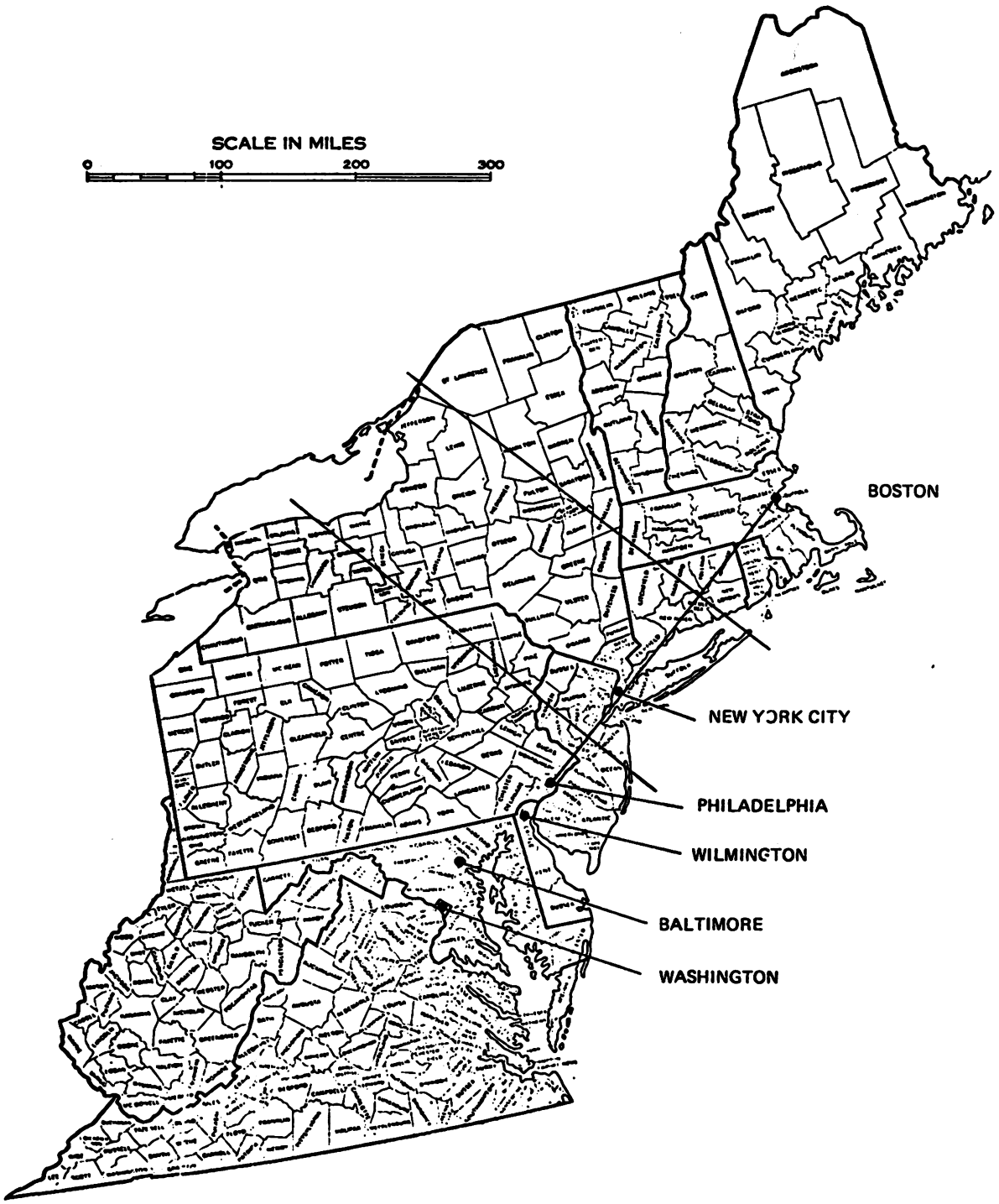


Figure 2 LOCATION OF HINTERLAND RELATIVE TO MAJOR CITIES

cular hosting ratio, the following procedure is followed:

a. On a suitable worksheet, such as shown in Table 6, list all the States of the planning region, grouping the States that have the same general pattern of relocation flow.

b. Enter the risk population and host population for each State.

c. Choose a trial hosting ratio and calculate the hosting capacity by multiplying the host population of each State by the assumed hosting ratio.

d. Compare the hosting capacity of the State with the blast risk population, and obtain the surplus or deficit in hosting space on a State-by-State basis.

e. Calculate the cumulative surplus or deficit hosting capacity for each group of States. This can be shown as subtotals for each group of States, or a column of cumulative surplus or deficit capacity can be used.

In Table 6 the above process is applied to the Northeastern planning region. Subtotal A represents the New England States. If this group is regarded in isolation, there is a deficit of over one million spaces at a hosting ratio of 5 (equivalent to a space allocation of 20 square feet per relocatee), assuming that the distant part of Maine is fully used. The addition of New York State (subtotal B) compensates for this deficit and shows a small surplus, again assuming that all host areas are used. This result shows that New England really needs the part of New York that is closest to Boston in Figure 2. A running summation of host capacity in this area would show how many New York counties should be dedicated to the Boston planning area. Similarly, it can be seen from Table 6 that New Jersey can be housed in Pennsylvania with a substantial surplus overall. Thus, some northeastern Pennsylvania counties could be assigned to the New York planning area in an attempt to equalize relocation distances. Finally, the last group of States are those below the Mason-Dixon line. There is a very substantial surplus hosting capacity in this area at a hosting ratio of 5. This suggests that the remote parts of Virginia and West Virginia are not really needed in the regional allocation, or else that the hosting ratio can be reduced for this group.

Tentative Planning Areas

The potential hosting capacities calculated above, when compared with transportation networks, provide the basis for delineating planning areas, as shown in Figure 3 (Northeastern planning region). Because there is a surplus of hosting capacity in Pennsylvania, Baltimore relocatees are allowed to move up Interstate 70 to its intersection with

Table 6

HOSTING SITUATION IN STUDY AREA AT 20 SQ FT PER CAPITA

State	Blast Risk	Host Population	Capacity	Surplus (+) Deficit (-)
Maine	329,494	662,554	3,312,770	2,983,276 (+)
New Hampshire	319,957	336,529	1,682,645	1,362,688 (+)
Vermont	83,093	361,639	1,808,195	1,725,102 (+)
Massachusetts	5,199,509	251,680	1,258,400	3,941,109 (-)
Rhode Island	912,276	---	---	912,276 (-)
Connecticut	2,710,652	85,840	429,200	2,281,452 (-)
Subtotal "A"	9,554,981	1,698,242	8,491,210	1,063,771 (-)
New York	14,868,035	3,201,838	16,009,190	1,141,155 (+)
Subtotal "B"	24,423,016	4,900,080	24,500,400	77,384 (+)
New Jersey	6,490,144	145,143	725,715	5,764,429 (-)
Pennsylvania	8,136,736	3,349,185	16,745,925	8,609,189 (+)
Subtotal "C"	39,049,896	8,394,408	41,972,040	2,922,144 (+)
Delaware	425,530	80,356	401,780	23,750 (-)
Maryland	3,344,361	300,021	1,500,105	1,844,256 (-)
D. C.	756,510	---	---	756,510 (-)
Virginia	2,799,638	1,844,746	9,223,730	6,424,092 (+)
West Virginia	505,961	1,238,140	6,190,700	5,684,739 (+)
TOTAL	46,881,896	11,857,671	59,288,355	12,406,459 (+)

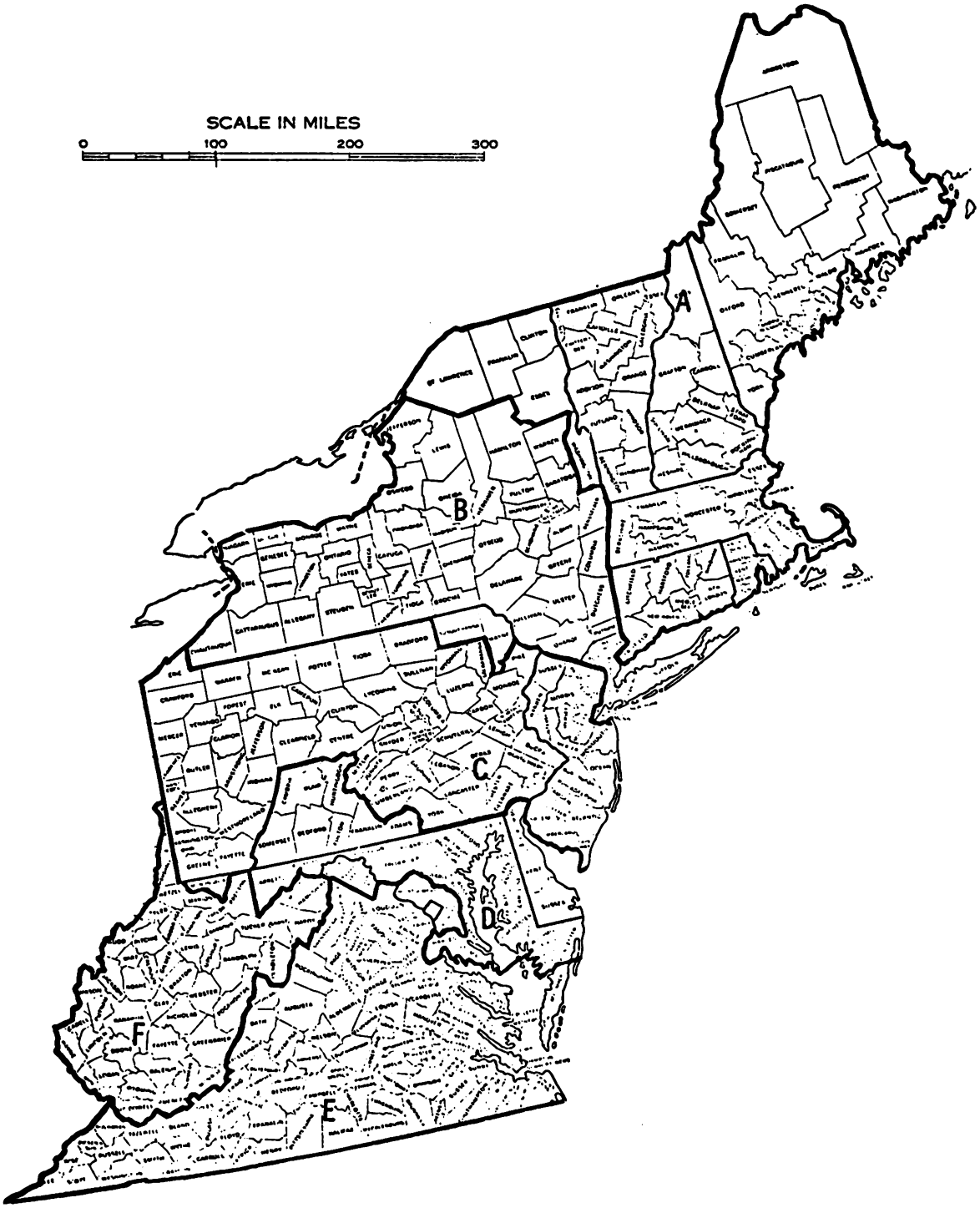


Figure 3 TENTATIVE PLANNING AREAS

the Pennsylvania Turnpike, using eight counties in Pennsylvania as well as the three easternmost counties of West Virginia. The basis for the other boundaries to the north has been discussed. Most of West Virginia is made a separate planning area with the likelihood that it would not be needed by either the seaboard cities or Pittsburgh. This should be confirmed by the general allocations described later.

The above procedure works well in a large planning region composed of many States. It does not provide enough geographic definition in a smaller planning region, such as the Midwest example. If the five States of DCPA Region 4 are listed from east to west, for example, one can conclude that Ohio and Michigan tend to look to Indiana for hosting space and that Illinois looks both east to Indiana and north to Wisconsin. This information is insufficient to aid in defining tentative planning area boundaries. An alternative procedure is to outline "maximum" hosting areas for the largest population centers and make adjustments as necessary after a trial allocation is performed. As an example, the Chicago planning area initially might follow the Wisconsin State line west from Lake Michigan to the eastern boundary of Rock County (which is served by Interstate 90), then north, then west along the northern boundaries of Rock and Green Counties (to then force Madison to move north), then generally northwest in the area serviced by U.S. highways 14 and 18 tc include Vernon County just south of La Crosse, Wisconsin. The planning area would then follow the boundary of the planning region south along the Mississippi and include all of Illinois, even though the southern part of the State would probably not be fully used. The Chicago planning area might also include parts of Indiana north of a line of county boundaries in the vicinity of Lafayette and Marion, and parts of Michigan, such as Berrien, Cass, St. Joseph, Van Buren, and Allegan Counties.

This trial definition of the Chicago planning area automatically defines the Milwaukee planning area and partially defines the Detroit and Cincinnati planning areas. The Detroit planning area might be taken initially as the remainder of Michigan, all of northwestern Ohio from Sandusky County on Lake Erie to Mercer County on the Indiana border, and hence across Indiana. Finally, a boundary would be chosen between the Cleveland and Cincinnati planning areas, taking into account the road network and the fact that Cincinnati relocatees could move west into southern Indiana.

The General Allocation

The suitability of the tentative planning area boundaries should be tested by performing a "general allocation" of risk area populations to the host counties of each planning area. The general allocation indicates the average and maximum relocation distances at a particular

hosting ratio or equivalent housing space allocation, for each planning area. A series of general allocations for all of the planning areas indicates whether or not the planning region has been appropriately subdivided.

The concept underlying the general allocation is that of "relocation flow," as described in Chapter 1--i.e., the allocation of risk populations to host areas will be dominated by the outward flow from the large population center that is the focal point of a planning area. In a general allocation, relocation flow is only approximated, and the average and maximum relocation distances are determined for only the largest risk area, not for every risk area. Nontheless, the general allocation provides the essential information that the planner needs as a basis for making a later detailed allocation of the population of each risk area to specific host counties. It also leads to the selection of planning area boundaries that are suitable for further transportation analysis.

The process begins by allocating the risk area residents of the principal city to nearby host counties in accordance with the direction of the relocation flow. As smaller risk areas are encountered in the outward movement, the risk population of the smaller risk areas is a added to the unallocated remaining risk population from the principal city. Ultimately, all of the risk population in the planning area is allocated to hosting space in a direction away from the principal city, unless the process ends before the most remote risk areas are reached. (For example, people from New York City never need to go as far as Buffalo, nor do Philadelphia residents need to go as far as Pittsburgh.)

The detailed procedures for making a general allocation are illustrated in Table 7 and listed below:

a. On a suitable worksheet list all of the counties in the planning area in the approximate order of distance from the major population center. Start the list with the risk county most remote from the host center.

b. For each county determine the risk population and the host population, if any, from the ADAGIO printout.*

c. Calculate the hosting capacity of each county by multiplying the host population by the assumed hosting ratio.

d. Enter on the worksheet the risk population and the hosting capacity of each county.

*Step by step procedures for obtaining the required data from the ADAGIO printouts are presented at the end of this chapter.

Table 7

EXAMPLE GENERAL ALLOCATION

(Tentative Planning Area B at Hosting Ratio of Five)

County	Risk Pop.	Cum. Risk Pop.	Host Cap.	Cum. Host Cap.	
Suffolk	1,061,628	1,061,628	*	*	
Nassau	1,428,838	2,490,465			
Queens	1,986,473	4,476,939			
Kings	2,602,012	7,078,951			
Richmond	295,443	7,374,394			
New York	1,539,233	8,913,627			
Bronx	1,471,701	10,385,328			
Westchester	853,572	11,238,900			
Rockland	226,155	11,465,055			
Putnam	13,252	11,478,307	217,220	217,220	
Orange	--+	11,478,307	1,102,790	1,320,010	
Dutchess	--	11,478,307	1,111,475	2,431,485	(20%)
Ulster	--	11,478,307	706,205	3,137,690	
Sullivan	--	11,478,307	262,900	3,400,590	
Columbia	--	11,478,307	257,595	3,658,185	
Greene	--	11,478,307	165,680	3,823,865	
Delaware	--	11,478,307	223,590	4,047,455	
Wayne, PA	5,254	11,483,561	121,635	4,169,090	
Rensselaer	128,698	11,612,259	119,060	4,288,150	
Albany	277,989	11,890,248	38,145	4,326,295	
Schoharie	--	11,890,248	123,750	4,450,045	
Schenectady	157,179	12,047,427	19,000	4,469,045	
Montgomery	--	12,047,427	279,415	4,748,460	
Saratoga	37,470	12,084,897	421,040	5,169,500	
Fulton	--	12,084,897	263,185	5,432,685	
Herkimer	10,831	12,095,728	283,005	5,715,690	
Otsego	--	12,095,728	280,905	5,996,595	
Chenango	--	12,095,728	231,840	6,228,435	(50%)
Broome	183,181	12,278,909	193,170	6,421,605	
Susquehanna, PA	--	12,278,909	171,720	6,593,325	
Warren	--	12,278,909	247,010	6,840,335	
Hamilton	--	12,278,909	23,570	6,863,905	
Oneida	218,963	12,497,872	270,370	7,134,275	
Madison	29,421	12,527,293	167,215	7,301,490	
Cortland	--	12,527,293	229,470	7,530,960	
Tioga	--	12,527,293	232,565	7,763,525	
Lewis	--	12,527,293	118,220	7,881,745	
Oswego	19,277	12,546,570	408,100	8,289,845	

Table 7 (Concluded)

County	Cum. Risk Pop.	Risk Pop.	Host Cap.	Cum. Host Cap.	
Onandaga	472,185	13,018,755		8,289,845	
Cayuga	---	13,018,755	387,195	8,677,040	
Tompkins	---	13,018,755	384,395	9,061,435	
Chemung	---	13,018,755	507,685	9,569,120	
Seneca	---	13,018,755	175,415	9,744,535	
Schuyler	---	13,018,755	83,685	9,828,220	
Wayne	---	13,018,755	397,020	10,225,240	
Ontario	---	13,018,755	394,245	10,619,485	
Yates	---	13,018,755	99,155	10,718,640	
Steuben	---	13,018,755	497,730	11,216,370	
Allegany	---	13,018,755	232,290	11,448,660	
Livingston	---	13,018,755	270,205	11,718,865	
Jefferson	---	13,018,755	442,540	12,161,405	
Monroe	658,617	13,677,372	266,500	12,427,905	
Wyoming	---	13,677,372	188,440	12,616,345	
Genessee	---	13,677,372	293,610	12,909,955	
Orleans	---	13,677,372	186,525	13,096,480	
Cattaraugus	---	13,677,372	408,330	13,504,810	
Chautauqua	---	13,677,372	736,525	14,241,335	(100%)
Erie	1,009,007	14,686,379	522,420	14,763,755	
Niagara	160,919	14,847,298	374,005	15,137,760	

*Blank spaces mean that all the population must be relocated (zero host capacity).

†Dashes ("---") indicate that the population of the given county is not at risk, and hence does not need to be relocated.

e. Accumulate the risk population and the host capacities as shown in the table, adding the quantity for each county to the sum for those higher on the list.

f. Compare cumulative risk population with the cumulative host capacity:

- When the accumulated host capacity equals 20% of the accumulated risk population, write "20%" in the last column, as shown in Table 7. The county marked "20%" indicates the maximum commuting distance for essential workers to the principal city*. (Use Mileage Guide.)

- When the host capacity reaches one-half of the accumulated risk population, write "50%" in the last column, as shown in Table 7. The county marked "50%" indicates the average relocation distance from the principal city. (Use Mileage Guide.)

- When the host capacity equals the accumulated risk population, write "100%" in the last column, as shown in Table 7. This indicates that the relocation flow from the principal city and the intervening risk areas has been accomodated. The county marked "100%" indicates the maximum relocation distance from the principal city. (Use Mileage Guide.)

The example general allocation shown in Table 7 is for Planning Area B at a planned hosting ratio of 5. New York City, which encompasses several counties, is the principal population center in this planning area. In the example, we start the list of counties with Suffolk County on Long Island because it is upstream from the main relocation flow. A map of the area indicates that Queens County is about the center of the New York City complex; therefore, counties outside New York City are listed in the approximate order of distance from Queens, guided occasionally by linear measurements taken from a map of the state. Erie County and Niagara County (Buffalo) are intentionally placed at the end of the list because they represent another large city.

Because the general allocation process starts with the largest risk area, the cumulative risk population rises sharply at first and then levels off when host counties are encountered, as indicated in

*On the basis of current knowledge, it is assumed that key workers constitute 20% of the work forces and that 20% of the population will require close-in hosting accommodations as key workers and their families. Ongoing and future studies may change this assumption.

the third column of the example table. On the other hand, the cumulative host capacity (last column) increases gradually until it eventually reaches and exceeds the cumulative risk population.

In the example shown in Table 7, the essential workers (20% of the population) of New York City and vicinity are hosted in Putnam, Orange, and Dutchess Counties. The mileage guide indicates that the maximum commuting distance back to Nassau County is 108 miles. The "average" relocation distance is 178 miles and the maximum relocation distance is 350 miles.

Adjusting a General Allocation

The general allocation described above is a simple but versatile planning tool since it involves only successive additions after the counties in a planning area have been properly ordered in the direction of relocation flow. Many trial allocations can be performed readily to explore alternative assumptions and to improve the definition of the boundaries of the planning areas. Initially, a general allocation should be made for each planning area within the planning region. The initial results will usually be unsatisfactory in one or more respects. The planner should examine the results for each planning area and compare results for adjacent planning areas with a view towards improvement.

Occasionally, it may be found that the hosting capacity within an assumed planning area is insufficient to accommodate the risk population at the assumed hosting ratio. To increase hosting capacity, the planning area can be made larger by shifting one or more counties from an adjacent planning area, the area with the best distance solution if there is a choice. The shortfall in hosting capacity indicated at the end of the general allocation can be compared with the hosting capacities of candidate counties in the neighboring planning area to determine which counties and how many should be shifted. The surplus in hosting capacity at the end of the allocation for the adjacent planning area should be noted also to make sure that the transfer will not result in a shortfall there. If such is the case, it may be necessary to compensate by adjustments in still other planning areas. For example, were it found necessary to include additional northern Pennsylvania counties in the New York planning area, it may be necessary also to withdraw some Pennsylvania counties from the Baltimore planning area and extend the Baltimore area further down the Shenandoah valley of Virginia. Once such adjustments are identified, the affected counties, usually only a few, should be deleted from the allocation listings where appropriate and added into the neighboring listings in the proper place in the relocation flow. The general allocation procedure can then be performed again and the results compared.

Alternatively, the hosting ratio can be increased in one or more planning areas to increase the hosting capacity where needed or to

reduce the maximum relocation distance. This can be done without performing a new general allocation. For example, changing the hosting ratio in Table 7 from 5 to 6 is equivalent to an increase of 20 percent in the hosting capacity of all host counties. Thus, starting with the original 100 percent county (Chautauqua), one searches up the listing, multiplying the listed cumulative hosting capacity by the factor 1.2 (120 percent) until some county fails to yield a capacity in excess of the cumulative risk population to that point. In Table 7, this occurs at Yates County. The next county downstream, Steuben, exceeds the risk population and hence the main relocation flow would terminate there--reducing the maximum relocation distance by about 60 miles. The revised maximum relocation distance is 290 miles.

Often, it is desirable to explore other kinds of adjustments by means of this general allocation procedure, before fixing on the boundaries of the planning areas. One such adjustment concerns non-highway modes of transportation. The allocation shown in Table 7 and the conclusions drawn from it are based on the implicit assumption that the entire risk population will travel by highway; that is, distances along the relocation flow are intended to be highway distances and the concern about average and maximum reloation distances relates to the need for refueling of highway vehicles for the most part. As discussed in Chapter 3, many families without autos may be relocated by non-highway modes of transportation. Preliminary analyses of non-highway transportation capacities can be reflected in the general allocation.

For example, suppose it was contemplated to move some of the carless in New York City to Buffalo by air where they would be bussed into nearby host counties. From Table 7, it can be seen that the Buffalo risk population can be hosted within Erie County, Niagara County, and part of Chautauqua County, leaving highways from the Buffalo Airport free to bus airlifted persons east and southeast to Cattaraugus, Wyoming, Genessee, and Orleans Counties. Because the Buffalo Airport is a large airport, we can assume provisionally that 108,000 people could be airlifted into Buffalo over a three-day period, using the preliminary factors given in Chapter 3. The New York airports are located in Queens County. This airlift can be reflected in the general allocation by reducing the risk population of Queens by the airlifted amount and also reducing the host capacity of, say, Cattaraugus and Chautauqua Counties by a like amount in a way so as to substitute airlifted persons for highway travelers in the most remote part of the planning area. In effect, the non-highway mode capacities are simply deducted from both risk and host populations at the appropriate locations. The general allocation is then redone for the remaining risk population, which is assumed to travel by highway.[2]

In processing the above example, one should review the "first auto" calculation of Chapter 3 for Queens County to make sure that sufficient carless people are available for airlift. Otherwise, passengers could be drawn from neighboring Kings and Nassau. There is no intention at this point to do any detailed planning with respect to the airlift but it is good practice to draw down the risk population where it is reasonably likely to occur. Obviously, other risk and host airports could be included in the modified general allocation, as well as rail and water passengers.

The general allocation described in this chapter will often be found useful in evaluating the effect of other adjustments in either the risk population or hosting capacity. The adjustments in blast and fallout risk populations are discussed in Chapter 6 and can be reflected in a modified general allocation. The techniques described in the same chapter for minimizing fallout shelter construction can also be reflected in a general allocation by appropriate adjustment of the assigned hosting capacity based on fallout risk.

Finally, survey results of congregate-care capacity can be incorporated into the general allocation format. If some or all of the counties in a planning area have been surveyed, the results can be substituted for the hosting ratio estimate of hosting capacity but this must be done carefully to reflect the hosting assumptions. As discussed in the Introduction, not all of the congregate-care space located by survey will prove usable in the detailed planning phase. Therefore, the survey total for a particular county should be reduced by one-third to account for spaces not used for housing relocatees. The result, two-thirds of the original total, represents the number of usable 40-square-foot housing spaces in the county. (On the average, this result will be about 2.5 times the number of residents in the host county. Nationwide, about half of all non-metropolitan counties that have been surveyed are within 20 percent of the average.) Next, the county housing capacity should be adjusted to the reduced space allocation appropriate to the planning region. In the Northeast example, we have been using a hosting ratio of 5 (20 square feet per person.) Therefore, the usable 40-square-foot spaces should be multiplied by two to account for the reduced allotment. The result can be entered into the hosting capacity column in lieu of the number representing five times the host population. A similar approach can be used to incorporate survey results in counties with both risk and host areas. In this way, the general allocation can be adjusted to reflect all of the available planning information.

ATTACHMENT TO CHAPTER 4 - PROCEDURE FOR OBTAINING RISK AND HOST POPULATIONS

The risk population for an initial general allocation should be drawn from the ADAGIO printout using the procedure in the Attachment to Chapter 3.

The host population is obtained in one of the following two ways:

(a) If there is no blast risk population in the county, this will be stated in the second line of the printout for the county. The host population is the total population of the county, provided that the county is not at fallout risk. The total population of the county is given on the top line of the county listing as the first of four numbers (T-U-R-UA). Also, check the right-hand number at the end of the first line. If it is a 3, the county is at fallout risk and should not be used for hosting. If it is not a 3, multiply the county population by the hosting ratio (5 in the example) and enter under Host Capacity on the general allocation sheet.

(b) If there is a risk population in the county, and it is not at fallout risk, the bottom line of the county summary will give a "Risk Reduced County Reception Center Popn" number, which is the host population. If there are two population values, rural and urban, they must be added together to obtain the host population. This in turn is multiplied by the hosting ratio to obtain the hosting capacity for use in the allocation.

Notes to Chapter 4

1. Again, planners are admonished to proceed carefully when contemplating higher hosting ratios. The feasibility of a 10 square feet per person allocation has not yet been established in terms of either operational credibility or public acceptance.

2. Planners should keep in mind that subsequent movement of air-lifted evacuees to hosting areas will certainly have an impact on the total number of people that should be air-lifted.

5. ASSESSING TRANSPORTATION CAPACITIES

To a great extent, the practicability of the general allocations made in Chapter 3 will depend on making the most effective use of the available highway networks and vehicles in combination with non-highway modes. The preliminary transportation analysis in Chapter 3 indicated the numbers of persons in large risk areas with access to a first auto, and indicated the numbers of carless persons. Some carless persons can be moved by non-highway modes. The remainder must be moved over the network of roads and highways leading from the large risk area into its planning area.

Transportation planners can view the road and highway network as being made up of three elements:

- The feeder element includes streets and minor roads in the risk area.
- The line-haul network includes roads for the heavy traffic flows between risk and host areas.
- The distribution network is made up of streets and minor roads in the host area.

Of these elements, only the line-haul network is a critical resource, and it should be defined so as to include all the highway routes that require close supervision and control. The potential capacity of the line-haul network is a critical factor in planning relocation from large risk areas. In this chapter, we will consider methods of estimating and evaluating the capacity of the highway networks under various operational schemes.

Highway Capacity Factors

Planning teams must devise a set of highway capacity factors for line-haul routes tailored to local conditions. Existing knowledge of highway capacities is concentrated on normal traffic conditions and peak loads such as morning and evening traffic on commuter routes, and does not translate directly to long periods of sustained heavy traffic flow. Therefore, planning teams must carefully approach the subject of highway capacity estimation, with special attention to crisis conditions.

Early civil defense studies dealing with tactical evacuation used an average capacity factor of a thousand cars per hour per lane without attempting to differentiate between one type of road

and another. The findings of the feasibility study suggest that the use of a single factor may be appropriate only where road capacity is in long supply. Where road capacity is in short supply, several more detailed factors will be needed in crisis relocation planning for large risk areas. Precise planning factors and close control will be necessary to realize the most effective use of limited line-haul resources. The line-haul routes should be mapped and their conditions and capacities should be described in detail throughout their lengths. Restriction of capacity for short distances at critical points can limit the capacity of an entire route. All such bottlenecks should be noted.

Planning teams should seek guidance and assistance from traffic specialists in local and State agencies to develop highway capacity planning factors appropriate to their planning area. In the feasibility study, the literature of highway capacities was reviewed and interpreted to produce a set of typical capacity factors for use in case studies. For illustrative purposes, these typical factors are presented below:

(1) Each lane of limited access highway is assumed to have a capacity of 30,000 automobiles per day based upon average flows of 1,500 vehicles per hour and the equivalent of 20 hours of operation per day, or 90,000 cars in a three-day period.

(2) Each lane of a multi-lane, two-way divided highway is assumed to have a capacity of 24,000 cars per day, based upon 1,200 vehicles per hour and 20 hours per day, or 72,000 cars in a three-day period. This factor assumes close control of traffic and relatively severe limitations on turning and crossing traffic.

(3) A two-lane, two-way road is assumed to have a capacity of 18,000 cars per day in the peak direction based on 900 vehicles per hour and 20 hours per day, or 54,000 cars in a three-day period. This factor allows for 100 vehicles per hour in the off-peak direction. It also assumes close control of traffic and severe limitations on turning and crossing traffic.

(4) Small numbers of trucks (e.g., 1%) are assumed capable of moving in streams of autos without reducing carrying capacity for auto traffic. If large numbers of buses or trucks are needed, it is assumed that certain lanes (or entire roads) will be reserved for the large vehicles. Such lanes are assumed to have capacities in the ratio of one large vehicle to four autos--e.g.,

375, 300, and 225 large vehicles per hour per lane for the types of roads identified in items (1), (2), and (3) above, or 22,500, 18,000, and 13,500 large vehicles in a three-day period.

(5) Multi-lane limited-access highways and multi-lane two-way divided highways are assumed to be convertible to one-way routes when the additional capacity is needed. Such conversions are subject only to the requirement that some other route is found to recycle a small flow of highway patrol and other emergency vehicles.[1]

The above typical planning factors were derived from the Highway Capacity Manual, published in 1965 by the Highway Research Board, National Academy of Sciences, National Research Council. The manual contains a wealth of data on the capacities of typical highways under various conditions and is accepted as the standard authority on the subject.

Capacity factors should not be interpreted as universally applicable--actual traffic carried by a highway can be much lower than rated capacity. For example, when the number of vehicles seeking entry to a highway falls below capacity for a significant period, the loss of capacity cannot be made up. If too many vehicles enter the road, it will become congested and there will be a loss of both speed and capacity. Failure to remove stalled vehicles and to clear accidents will reduce capacity.

Estimating Highways Capacities

After determining the highway capacity planning factors for the area and the origin and number of trips by first autos, it is necessary to determine the capacity of the highway networks from the risk area to the host area. This determination is made by a procedure called the cordon technique, which is a simple though inexact way of determining the available highway capacity. In using the cordon technique, the analyst draws a line on a map between the risk area and the host area at a location that represents his best estimate of the zone where the required highway capacity will be the highest in comparison to the capacity available. He is looking for the place where natural bottlenecks will occur. He then applies the previously determined highway capacity factors to the roads crossing the cordon, and compares the results with the population that must cross the cordon.

Each successive application of the cordon technique should follow these steps:

a. For the risk area of concern, prepare a worksheet with column headings as shown below:

Highway	Description	Outbound Lanes	Three-Day Capacity of Highway Thousands: Vehicles/ Lane	Vehicles/ Highway	Persons/ Highway

b. On a map draw a line indicating a cordon between the risk area and the host area at a location that represents the planning teams' best estimate of the zone where the highway capacity is most likely to restrict the relocation movement. The line represents the zone where the highway capacity will be lowest in comparison to the capacity required, and is the zone where natural bottlenecks are most likely to occur.

c. Identify all highway routes from the risk area to the host area that cross the cordon line.

d. Determine the characteristics of each route as it crosses the cordon line and enter the highway name or number, the highway description (divided, limited access, etc.), and the number of lanes on the worksheet. In describing the individual highways, classifications that correspond to the previously determined highway capacity factors should be used.

e. Trace each highway toward the risk area and toward the host area for a reasonable distance to be sure that the characteristics of the highway and the number of lanes observed at the cordon are in fact typical of the route.

f. Compute the three-day highway capacity (number of vehicles per lane and total vehicles for each highway) using the previously derived highway capacity factors.

g. Compute the number of persons that can be carried on each highway by multiplying the number of vehicles per highway by the average number of persons per vehicle.

h. Compute the total number of vehicles and the total number of persons for all highways crossing the cordon.

i. Compare the highway capacity available (step h) with the highway capacity required (the number of persons that would have to cross the cordon). The number of persons crossing the cordon depends on the location of the cordon. It is the risk population that cannot be relocated by non-highway modes minus the hosting capacity, if any, of the area between the risk area and the cordon.

The results will enable the planning team to make preliminary judgments regarding whether the highway system, in combination with the previously identified non-highway modes, is adequate to relocate the large risk area's population within the planned limit of three days. For smaller urbanized areas, a single determination of highway capacity in terms of first autos will usually be sufficient to analyze the problem. For large risk areas, it will usually be necessary to repeat the cordon technique several times for different combinations of vehicles, for one-way versus round trip traffic, and for situations where the cordon is drawn at increasing distances from the risk area.

The cordon lines that were used to estimate highway capacity during the feasibility study are shown in Figure 4. These cordon lines and the resulting capacity estimates were sufficient to analyze the problem of feasibility. Crisis relocation planning will require much more thorough analysis than was needed to study feasibility. The location of the cordon lines will have to be carefully selected, based on an in-depth survey of the highway characteristics. Routes that join or are not entirely independent will have to be identified and some or all of their lanes may have to be eliminated from the list of those crossing the cordon. First, the team should conduct a series of desk-top analyses using highway map data. Then the team should actually drive the routes, consult with traffic and highway officials to confirm the highway system characteristics, and revise the desk-top analysis as appropriate.

The estimated capacities of highways leading from the New York City risk area are shown in Table 8. The estimate assumes the use of automobiles only and assumes that traffic will move in the normal direction in each lane. (For automobiles, the average number of persons per vehicle is determined from Table 5 by dividing the total population by the total occupied housing units--line 1 total ÷ line 3 total.)

Table 8 indicates that the three-day capacity of the highway system is 3,348,000 persons in automobiles. In comparison, the preliminary transportation analysis for the same risk area identified a total risk population of 11.4 million persons including 6.6 million persons with access to first autos. A simple calculation indicates that almost six days would be required to relocate only those with automobiles. Other vehicles and additional time would be required for the carless that cannot be moved by non-highway modes. Obviously in this example, crisis relocation plans must provide for measures that will increase highway capacity in order to reduce the time required for relocation. The example also emphasizes the importance of exploiting the non-highway modes which were described in Chapter 3.

Figure 4 KEY CORDONS

Table 8

NEW YORK CITY RISK AREA: HIGHWAY CAPACITY--AUTOMOBILES
(Three Days)

Highway	Description	Outbound Lanes	Three-Day Capacity of Highway Thousands		
			Vehicles/ Lane	Vehicles/ Highway	Persons/ Highway
I-87, Bronx River and I-287	Divided, limited access	3	90	270	810
Palisades Interstate	Divided, limited access	2	90	180	540
9W	Undivided	1	54	54	162
Sawmill River and Taconic	Divided, limited access[1]	2	90	180	540
Sprain Brook and 9	Undivided	1	54	54	162
22 and 101	Undivided	1	54	54	162
Hutchinson River, I-95, and 684	Divided, limited access	3	90	270	810
17 and 208	Undivided	1	54	54	162
	Total Capacity	14		1,116	3,348

[1]It is assumed that several uncontrolled access points on this route are blocked.

Measures to Increase Highway System Capacity

There are two basic ways of increasing the effective capacity of the highway system. One is to use vehicles with a larger load capacity--buses and trucks. The other is to change the characteristics of the highway system--e.g., changing from two way to one way outbound, closing off intersections, etc.

One-Way Outbound

In cases where highway capacity is insufficient to carry the numbers of first autos in the risk area, a measure that is extremely important is the use of divided, limited access roads as one-way roads outbound. On multi-lane highways, the available lanes can be regulated in various ways (and often are in commuter areas), shoulders and parking lanes can be used for an extra lane of traffic, and the like. A detailed survey of the route is usually needed to determine what is possible. The ultimate in this approach is to make all lanes outbound on one or more routes.

For the New York City example (Table 8), a conversion of all divided, limited access highways to one-way outbound travel would add 10 outbound lanes. The revised cordon count, shown in Table 9, is 2,016,000 automobiles carrying 6,048,000 people--an increase in highway capacity of 2,700,000 persons. The time required to relocate those with access to a first auto is reduced to approximately 3.3 days. However, this solution does not take care of the carless.

Buses and Trucks

In order to provide buses and trucks for relocation, planning teams will need to develop inventories of vehicles, and identify owners/operators. Large fleet owners warrant special attention because of their management abilities. An example of the inventory and potential capacity of buses and large trucks is given below for the New York City area. The listed capacity factors were estimated in the feasibility study and are less detailed and precise than needed for actual plans.

Type of Vehicle	Inventory	Capacity Factor	Single-Trip Capacity
Large buses	6,259	40	250,360
Small buses	10,550	30	316,500
Tractor trucks	9,760	30	292,800
	26,569		859,660

Table 9

ALL FREEWAYS OUTBOUND--AUTOMOBILES

Highway	Description	Outbound Lanes	Three-Day Capacity of Highway Thousands: Vehicles/ Lane	Vehicles/ Highway	Persons/ Highway
I-87, Bronx River and I-287	Divided, limited access	6	90	540	1620
Palisades Interstate	Divided, limited access	4	90	360	1080
9W	Undivided	1	54	54	162
Sawmill River and Taconic	Divided, limited access[1]	4	90	360	1080
Sprain Brook and 9	Undivided	1	54	54	162
22 and 101	Undivided	1	54	54	162
Hutchinson River, I-95, and 684	Divided, limited access	6	90	540	1620
17 and 208	Undivided	1	54	54	162
	Total Capacity	24		2,016	6,048

[1] It is assumed that several uncontrolled access points on this route are blocked.

Another 200,000 small trucks were identified in the feasibility study. However, small trucks were not judged to be a suitable substitute for automobiles.

The planning team should use the cordon technique to analyze highway capacity using buses and trucks in both one-way and round trip patterns. One-way patterns can be analyzed in a series of steps in which the planner converts first one outbound lane to buses and trucks, then two lanes, and so on, until the short-fall of passenger capacity is alleviated or until the inventory of buses and large trucks is exhausted. If the shortage of highway capacity remains a matter of concern at the end of the first series of steps, the planner should repeat the cordon analysis for the situation in which "first" autos are displaced by buses and large trucks operating in round trip patterns. Again, the analysis can be conducted in a series of steps starting with the conversion of two lanes, then four lanes, and so on, until the shortage is alleviated or the supply of large vehicles is exhausted.

In the example cordon analysis shown in Table 10, the New York Thruway is set aside for buses and large trucks operating in round trip patterns. The average capacity of the inventory of these large vehicles is 32 passengers. The highway system capacity is increased to 6,588,000--2,160,000 in buses and large trucks and 4,428,000 in first autos. Another 1,200,000 can be moved by non-highway modes according to preliminary transportation analysis in Chapter 3. Thus the total three-day capacity of highway and non-highway systems is 7,788,000 persons in three days. To relocate the entire risk population, about 4.4 days would be required, under this combination of buses, trucks, first autos, and non-highway modes.

It is also necessary to determine whether or not the inventory of buses and large trucks is sufficient. Assuming an average relocation distance of about 178 miles (from the general allocation), a speed of 40 miles per hour, and a turn-around time of one hour, a complete round trip would take approximately 10 hours. Six round trips would be possible in a three-day period. 67,500 round trips would be needed according to Table 10. At two round trips per day, about 11,250 buses and large trucks would be required. This is about 40 percent of the inventory.

The potential capacity of the highway system may be limited by the availability of buses and large trucks. This is shown by the example in Table 11. In this case seven outbound freeway lanes are devoted to buses and trucks and virtually all of the inventory must be used. The highway system capacity is increased to 7,308,000 persons--5,040,000 in buses and large trucks and 2,168,000 in first autos. Assuming that another 1,200,000 can be moved by non-highway

Table 10

ONE FREEWAY DEVOTED TO BUSES AND TRUCKS

Highway	Description	Outbound Lanes	Three-Day Capacity of Highway Thousands: Vehicles/ Lane	Vehicles/ Highway	Persons/ Highway
I-87, Bronx River and I-287	Divided, limited access	3	22.5 (buses & trucks)	67.5	2160*
Palisades Interstate	Divided, limited access	4	90	360	1080
9W	Undivided	1	54	54	162
Sawmill River and Taconic	Divided, limited access[1]	4	90	360	1080
Sprain Brook and 9	Undivided	1	54	54	162
22 and 101	Undivided	1	54	54	162
Hutchinson River, I-95, and 684	Divided, limited access	6	90	540	1620
17 and 208	Undivided	1	54	54	162
	Total Capacity	21			6,588

[1] It is assumed that several uncontrolled access points on this route are blocked.

* Average capacity of buses and trucks is 32 persons.

Table 11

MAXIMUM USE OF BUSES AND TRUCKS

Highway	Description	Outbound Lanes	Three-Day Capacity of Highway Thousands: Vehicles/ Lane	Vehicles/ Highway	Persons/ Highway
I-87, Bronx River and I-287	Divided, limited access	3	22.5 (buses & trucks)	67.5	2160
Palisades Interstate	Divided, limited access	2	22.5 (buses & trucks)	45	1440
9W	Undivided	1	54	54	162
Sawmill River and Taconic	Divided, limited access[1]	2	22.5 (buses & trucks)	45	1440
Sprain Brook and 9	Undivided	1	54	54	162
22 and 101	Undivided	1	54	108	162
Hutchinson River, I-95, and 684	Divided, limited access	6	90	270	1620
17 and 208	Undivided	2	54	54	162
	Total Capacity	14			7,308

[1] It is assumed that several uncontrolled access points on this route are blocked.

modes, the total system capacity is 8,508,000 persons in three days. About 4 days would be required to relocate the entire risk population under this assumed combination. Probably the major weakness in this example is the assumption that the entire inventory of buses and large trucks could be mobilized. However, if buses and large trucks were primarily used for relocating to host areas that are relatively close to the risk area, a smaller number of vehicles would be required.

Summary

The above examples illustrate how highway capacity factors and the cordon technique can be used to assess transportation capacities and to identify the most suitable way of using available transportation resources. In most planning areas, planners will find that the available transportation resources can be used in a way that will permit relocating all of the risk population in much less than three days. In highly urbanized planning areas, the time required to relocate the population of the larger risk areas will often approach and will sometimes exceed three days. In such situations, the planning team should determine whether the population to be relocated can be legitimately reduced, before making detailed transportation plans. Procedures for adjusting risk and host populations are discussed in Chapter 6. Detailed transportation analysis and planning procedures are discussed in Chapter 7.

Note to Chapter 5

1. This assumption is questionable. Theoretically, converting the highways to one-way routes is possible and a convenient solution to the movement problem. The actual conduct of such an event may be another matter, however. Operational, logistic, and control requirements could very well be overwhelming. Also, effective utilization of highways converted for one-way movement might ultimately be more dependent on human behavior than a function of the extraordinary traffic mechanisms that would be in effect.

6. ADJUSTING RISK AND HOST POPULATIONS

In all planning regions where reduced housing space allocations are necessary, where commuting or relocation distances are excessive, or where the assessment of transportation capacity indicates excessive time required to clear the city, it is essential to adjust the risk populations defined by the computer printout. Even where these problems are not severe, it is desirable to evaluate the risk definitions since adjustments can often be made at this planning stage that will aid in later definition of risk area boundaries that are both credible and easily communicated to the public. Moreover, early consideration of relative fallout risk can lead to satisfactory allocations that will ease detailed planning for the provision of fallout shelter to relocatees.

However the risk areas are defined, a basic planning assumption discussed in Section 2 of CPG-2-8-A is that crisis relocation planning will assume that all of the risk population must be moved and hosted. In practice, it is understood that, in an intense international crisis, some portion of the risk population may relocate spontaneously in advance of a relocation directive to second homes or relatives. At the same time, it is also anticipated that another portion of the risk population may refuse to relocate for various reasons. (Some risk-area residents cannot be moved for health reasons, but the numbers are small.) Faced with hosting or transportation difficulties, planners may be tempted to make their problems more manageable by forecasting some fraction of stayputs and early leavers and eliminating them from the planning. This temptation should be resisted since the fraction of the risk population not loading the transportation and hosting systems is unknown and subject to the specific conditions of the crisis. The adjustments discussed in this chapter are legitimate and can in themselves exert a powerful effect on the feasibility and timeliness of crisis relocation. If practical plans can be developed based on 100 percent relocation, then some slack may emerge in the event of relocation to compensate for unforseen complications.

Blast Risk Population

The population at blast risk is the population to be relocated. If one can reduce the numbers to be relocated, particularly in the large cities, highway capacities will be less taxed and housing in congregate-care facilities less crowded. The opportunity for adjustment of blast-risk populations at this planning stage lies in the way the blast-risk population is defined. As discussed in Chapter 3 of CPG-2-8-A, the population in an MCD (Minor Civil Division) is counted at risk if (a) the centroid of the MCD has a 50-50 chance of experiencing at least 2 psi blast over-

pressure, or (b) the MCD is included in an urbanized area, regardless of weapon effects. The reason for this dual definition lies in the possibility that the population can be regarded as a target in its own right or as merely colocated with important military or industrial targets. The latter case is related to the overpressure criterion based on designed attacks. The former case is related to the urbanized area criterion. Originally, urbanized areas were intended to be compact, closely settled territory generally having a population density of 1,000 inhabitants per square mile. More recently, however, the Bureau of Census has been allowing tentacles of urbanization to accrete on the main urbanized body, especially in the large metropolitan areas. This process not only tends to degrade the concept of targeting population concentrations but also creates a planning situation that is virtually impossible to make credible to the public.

A prime example is the New York area shown in Figure 5. The hatched and stippled areas on this map are parts of the urbanized areas, the white areas are not. Note the tentacle going up either side of the Hudson River above the edge of the blast risk area. This tentacle crosses upper Westchester County and terminates in Putnam County. Another tentacle in the vicinity juts out to the northeast. Two points should be made about these tentacles. First, these strips of minor urbanization are not suitable targets in their own right. Second, they do not correspond to political boundaries and would be almost impossible to describe in any emergency instructions to the public about crisis relocation. Indeed, it would not be credible to tell the residents of the white areas to stay put and at the same time send households in the tentacles to relocation sites several hundred miles distant.

Note in Table 7 that there are 13,252 persons listed at risk in Putnam County. They live in the urbanized tentacle. They should be deleted from the risk population. Moreover, since they are really part of the host population, five times their number can be added to the host capacity for Putnam County. Similarly, the risk population of Westchester and Rockland Counties can be reduced. However, no host capacity can be added because the two counties are judged to be at fallout risk. Nontheless, a careful screening of the computer printout, in conjunction with the Census publication "Number of Inhabitants" for the State of interest, can have a significant effect on the allocation in the densely populated areas. The Census publication contains maps of the urbanized areas in the State, similar to that in Figure 5. These can be used to judge where tentacles can be deleted if the computer printout shows the associated MCD to be at less than 2 psi. Guidance on how to obtain risk and host populations from the computer printout has been included in earlier chapters, but adjustments require a careful use of the printout data.

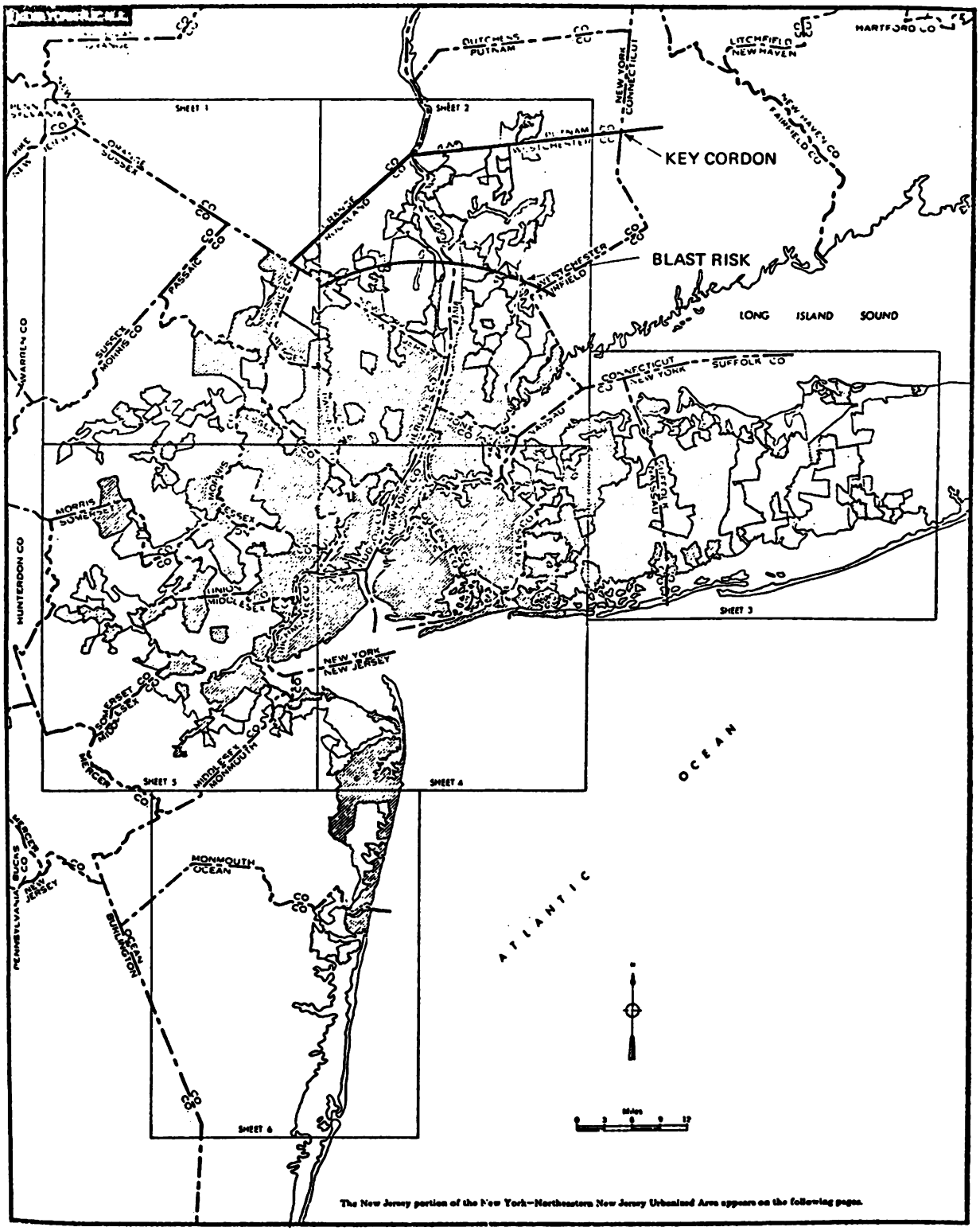


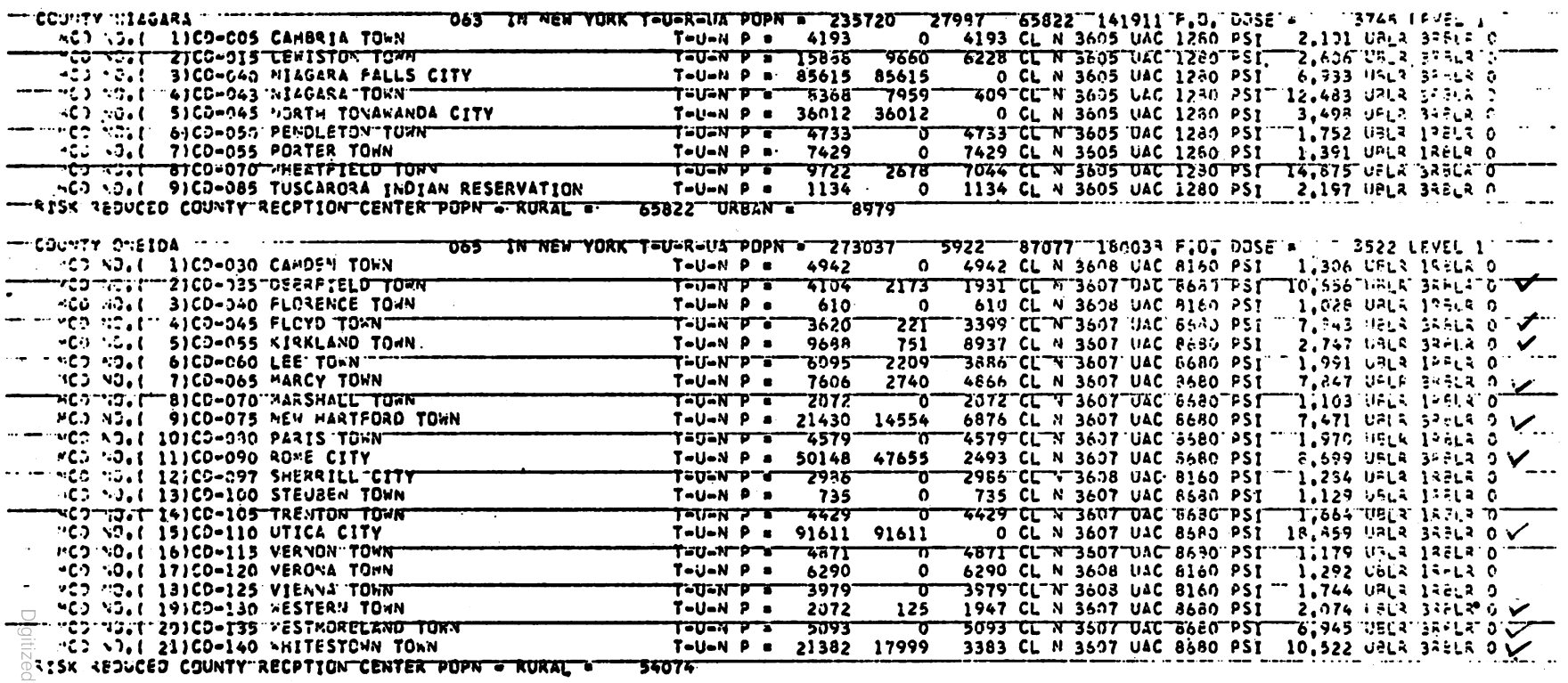
Figure 5 URBANIZATION IN THE NEW YORK AREA

Figure 6 presents part of a typical page from the printout for New York State. Consider the information given for Oneida County, which contains the Utica-Rome risk area. The top line gives the county name, number, State, and then a code for the following population numbers. For Oneida County, the total population (T) is 273,037, the urban population (those residing in towns outside the urbanized area) is 5,922, the rural population is 87,077, and the population of the urbanized area (UA) is 180,038. The remainder of the top line gives the probable fallout dose at the county centroid.

Below the top line is a listing of a set of MCDs within the county. For each MCD, there are three population figures given: total, urbanized area, and nonurbanized area. An important point to remember is that not all MCDs in the county may be listed. Only those that have a probable blast overpressure of at least 1 psi are shown. In Oneida County, some nine towns having a population of 14,695 persons are not listed, since their overpressure levels are less than 1 psi. It is not possible, directly, to tell whether any of the missing MCDs have urbanized population that could be deleted from the risk population. By adding up the second column for Oneida County, it can be determined that all of the urbanized area is represented, as the sum is 180,038 as given in the top line. In Putnam County (not shown), however, none of the MCDs with urbanized population are listed.

One method of risk population adjustment is to identify the population having a probable blast overpressure of 2 psi or more. Following the population data for each listed MCD is a "cluster number" and an "urbanized area code" that are of no interest to the planner. Then, following the letters PSI is the probable blast overpressure at the MCD centroid. Check those that are over 2 psi as shown in Figure 6. Add up the total population (first population column) for those checked. This is the provisional adjusted blast-risk population. The planner should then compare the blast-risk MCDs with the urbanized area map to see what has been left out that might be in the main urbanized body. In Oneida County, the only population deleted from the original blast-risk population by this procedure is 2,209 urbanized population in Lee Town. The urbanized area map in the Census publication, "Number of Inhabitants," shows that this population is a typical "tentacle" along the shore of Delta Reservoir and should be deleted. In other cases, planners will discover that attacks in the vicinity of Binghamton, NY and Atlantic City, NJ do not include the cities themselves. Decision will need to be requested on whether these small cities should be evacuated or used for hosting.

An alternative method is to work primarily from the map of each urbanized area, identifying tentacles and other urbanized parts that



COUNTY NIAGARA		063	IN NEW YORK	T=U=R=UA	POPN =	235720	27997	65822	141911	F.D. DOSE =		3745	LEVEL 1		
NCD ND.(	1)CD=005 CAMBRIA TOWN			T=U=N	P =	4193	0	4193	CL N	3605	UAC	1260	PSI	2,101	UBLR 3RBLR 0
NCD ND.(	2)CD=015 LEWISTON TOWN			T=U=N	P =	15856	9660	6228	CL N	3605	UAC	1260	PSI	2,606	UBLR 3RBLR 0
NCD ND.(	3)CD=040 NIAGARA FALLS CITY			T=U=N	P =	85615	85615	0	CL N	3605	UAC	1260	PSI	6,933	UBLR 3RBLR 0
NCD ND.(	4)CD=043 NIAGARA TOWN			T=U=N	P =	8368	7959	409	CL N	3605	UAC	1260	PSI	12,483	UBLR 3RBLR 0
NCD ND.(	5)CD=045 NORTH TONAWANDA CITY			T=U=N	P =	36012	36012	0	CL N	3605	UAC	1260	PSI	3,498	UBLR 3RBLR 0
NCD ND.(	6)CD=050 PENDLETON TOWN			T=U=N	P =	4733	0	4733	CL N	3605	UAC	1260	PSI	1,752	UBLR 1RBLR 0
NCD ND.(	7)CD=055 PORTER TOWN			T=U=N	P =	7429	0	7429	CL N	3605	UAC	1260	PSI	1,391	UBLR 1RBLR 0
NCD ND.(	8)CD=070 WHEATFIELD TOWN			T=U=N	P =	9722	2678	7044	CL N	3605	UAC	1260	PSI	14,875	UBLR 3RBLR 0
NCD ND.(	9)CD=085 TUSCARORA INDIAN RESERVATION			T=U=N	P =	1134	0	1134	CL N	3605	UAC	1280	PSI	2,197	UBLR 3RBLR 0
RISK REDUCED COUNTY RECPTION CENTER POPN = RURAL =			65822	URBAN =		8979									
COUNTY ONEIDA		065	IN NEW YORK	T=U=R=UA	POPN =	273037	5922	87077	180038	F.D. DOSE =		3522	LEVEL 1		
NCD ND.(	1)CD=030 CAMDEN TOWN			T=U=N	P =	4942	0	4942	CL N	3608	UAC	8160	PSI	1,306	UBLR 1RBLR 0
NCD ND.(	2)CD=035 DEERFIELD TOWN			T=U=N	P =	4104	2173	1931	CL N	3607	UAC	8680	PSI	10,556	UBLR 3RBLR 0 ✓
NCD ND.(	3)CD=040 FLORENCE TOWN			T=U=N	P =	610	0	610	CL N	3608	UAC	8160	PSI	1,028	UBLR 1RBLR 0
NCD ND.(	4)CD=045 FLOYD TOWN			T=U=N	P =	3620	221	3399	CL N	3607	UAC	8680	PSI	7,843	UBLR 3RBLR 0 ✓
NCD ND.(	5)CD=055 KIRKLAND TOWN			T=U=N	P =	9688	751	8937	CL N	3607	UAC	8680	PSI	2,747	UBLR 3RBLR 0 ✓
NCD ND.(	6)CD=060 LEE TOWN			T=U=N	P =	6095	2209	3886	CL N	3607	UAC	8680	PSI	1,991	UBLR 1RBLR 0
NCD ND.(	7)CD=065 MARCY TOWN			T=U=N	P =	7606	2740	4866	CL N	3607	UAC	8680	PSI	7,847	UBLR 3RBLR 0 ✓
NCD ND.(	8)CD=070 MARSHALL TOWN			T=U=N	P =	2072	0	2072	CL N	3607	UAC	8680	PSI	1,103	UBLR 1RBLR 0
NCD ND.(	9)CD=075 NEW HARTFORD TOWN			T=U=N	P =	21430	14554	6876	CL N	3607	UAC	8680	PSI	7,471	UBLR 3RBLR 0 ✓
NCD ND.(	10)CD=080 PARIS TOWN			T=U=N	P =	4579	0	4579	CL N	3607	UAC	8680	PSI	1,970	UBLR 1RBLR 0
NCD ND.(	11)CD=090 ROME CITY			T=U=N	P =	50148	47655	2493	CL N	3607	UAC	8680	PSI	8,599	UBLR 3RBLR 0 ✓
NCD ND.(	12)CD=097 SHERRILL CITY			T=U=N	P =	2986	0	2986	CL N	3608	UAC	8160	PSI	1,234	UBLR 1RBLR 0
NCD ND.(	13)CD=100 STEUBEN TOWN			T=U=N	P =	735	0	735	CL N	3607	UAC	8680	PSI	1,129	UBLR 1RBLR 0
NCD ND.(	14)CD=105 TRENTON TOWN			T=U=N	P =	4429	0	4429	CL N	3607	UAC	8680	PSI	1,664	UBLR 1RBLR 0
NCD ND.(	15)CD=110 UTICA CITY			T=U=N	P =	91611	91611	0	CL N	3607	UAC	8680	PSI	18,459	UBLR 3RBLR 0 ✓
NCD ND.(	16)CD=115 VERNON TOWN			T=U=N	P =	4871	0	4871	CL N	3607	UAC	8680	PSI	1,179	UBLR 1RBLR 0
NCD ND.(	17)CD=120 VERONA TOWN			T=U=N	P =	6290	0	6290	CL N	3608	UAC	8160	PSI	1,292	UBLR 1RBLR 0
NCD ND.(	18)CD=125 VIENNA TOWN			T=U=N	P =	3979	0	3979	CL N	3608	UAC	8160	PSI	1,744	UBLR 1RBLR 0
NCD ND.(	19)CD=130 WESTERN TOWN			T=U=N	P =	2072	125	1947	CL N	3607	UAC	8680	PSI	2,074	UBLR 3RBLR 0 ✓
NCD ND.(	20)CD=135 WESTMORELAND TOWN			T=U=N	P =	5093	0	5093	CL N	3607	UAC	8680	PSI	6,945	UBLR 3RBLR 0 ✓
NCD ND.(	21)CD=140 WHITESTOWN TOWN			T=U=N	P =	21382	17999	3383	CL N	3607	UAC	8680	PSI	10,522	UBLR 3RBLR 0 ✓
RISK REDUCED COUNTY RECPTION CENTER POPN = RURAL =			54074												

FIGURE 6

EXAMPLE PRINTOUT DATA

are candidates for deletion from the risk population. The printout is then consulted for each affected MCD to determine if the probable overpressure is less than 2 psi. If so, the urbanized population (second population column) is deducted. (If only part of the urbanized part of the MCD is a candidate for deletion, relative area can be used to estimate the population to be deducted.) If the affected MCD is not listed on the printout (as in Putnam County), consult Table 11 in the Census publication to determine the urbanized population to be deleted.

The effect of an adjustment of the blast-risk population as described here is demonstrated in Table 12, in which a general allocation is made similar to that in Table 7. The risk population in this allocation differs from that of the initial allocation in that only the population in MCDs with a probable blast overpressure of at least 2 psi has been included. There is little effect on the maximum commuting distance. However, the average relocation distance has moved from Chenango County to Otsego County, a reduction of about 20 miles. The maximum distance moves from Chautauqua County to Wyoming County. Indeed, only about 50,000 people from the east need to move as far as Rochester (Monroe County). Since these people would most likely originate in Syracuse, the maximum distance for relocatees from New York City would be well to the east of Rochester.

It should also be noted that the deletion of risk population in Westchester and Rockland Counties reduces the number of people who must cross the cordon line by 137,000 persons. Since the deletions occur in areas of very high automobile ownership, the reduction is equivalent to use of a limited-access lane for one and one-half days or an undivided highway for nearly three days. If the non-risk parts of Westchester and Rockland Counties could be used for hosting, the reduction in travel across the cordon would have been far greater.

Fallout Risk Population

The population in areas at fallout risk but not at blast risk do not need to be evacuated but they cannot host a part of the risk population. The current definition of fallout risk excludes counties from hosting relocatees if the centroid of population of the county is so located that there is a 50-50 chance of a 4-day dose exceeding 10,000 R. In other words, fallout risk is assessed only at the county centroid in contrast to blast risk, which is assessed at the much smaller MCD level. As a consequence, in some counties that are identified as high fallout risk counties, counties colored green in DCPA TR-82, there may be many MCDs in which the fallout risk is sufficiently low to permit hosting of relocatees. Generally, these MCDs will be upwind or crosswind from the direct effects area. Since the prevailing winds are from

Table 12

ADJUSTED TENTATIVE PLANNING AREA B AT HOSTING RATIO OF FIVE

(Population Adjusted for Blast Risk)

County	Risk Pop.	Cum. Risk Pop.	Host Cap.	Cum. Host Cap.	
Suffolk	1,061,628	1,061,628			
Nassau	1,428,838	2,290,465			
Queens	1,986,473	4,476,939			
Kings	2,602,012	7,078,951			
Richmond	295,443	7,374,394			
New York	1,539,233	8,913,627			
Bronx	1,471,701	10,385,328			
Westchester	750,901	11,136,229			
Rockland	191,900	11,328,129			
Putnam	--	11,328,129	283,480	283,480	
Orange	--		1,102,790	1,386,270	
Dutchess	--		1,111,475	2,497,745	(20%)
Ulster	--		706,205	3,203,950	
Sullivan	--		262,900	3,466,850	
Columbia	--		257,595	3,724,445	
Greene	--		165,680	3,890,125	
Delaware	--	11,328,129	223,590	4,113,715	
Wayne, PA	5,254	11,333,383	121,635	4,235,350	
Rensselaer	128,698	11,462,081	119,060	4,354,410	
Albany	277,989	11,740,070	38,145	4,392,555	
Schoharie	--	11,740,070	123,750	4,516,305	
Schenectady	157,179	11,897,249	19,000	4,535,305	
Montgomery	--	11,897,249	279,415	4,814,720	
Saratoga	35,485	11,932,734	430,965	5,245,685	
Fulton	--	11,932,734	263,185	5,508,870	
Herkimer	10,831	11,943,565	283,005	5,791,875	
Otsego	--	11,943,565	280,905	6,072,780	(50%)
Chenango	--	11,943,565	231,840	6,304,620	
Broome	91,338	12,034,903	652,385	6,957,005	
Susquehanna, PA	--		171,720	7,128,725	
Warren	--		247,010	7,375,735	
Hamilton	--	12,034,903	23,570	7,399,305	
Oneida	216,754	12,251,657	281,415	7,680,720	
Madison	29,421	12,281,078	167,215	7,847,935	
Cortland	--		229,470	8,077,405	
Tioga	--		232,565	8,309,970	
Lewis	--	12,281,078	118,220	8,428,190	
Oswego	19,277	12,300,355	408,100	8,836,290	
Onandaga	472,185	12,772,540		8,836,290	
Cayuga	--		387,195	9,223,485	
Tompkins	--		384,395	9,607,880	
Chemung	--		507,685	10,115,565	
Seneca	--		175,415	10,290,980	
Schuyler	--		83,685	10,374,665	
Wayne	--		397,020	10,771,685	
Ontario	--		394,245	11,165,930	
Yates	--		99,155	11,265,085	
Steuben	--	12,772,540	497,730	11,762,815	

Table 12 (Continued)

County	Risk Pop.	Cum. Risk Pop.	Host Cap.	Cum. Host Cap.	
Allegany	--	12,772,540	232,290	11,995,105	
Livingston	--		270,205	12,265,310	
Jefferson	--	12,772,540	442,540	12,707,850	
Monroe	608,446	13,380,986	517,355	13,225,205	
Wyoming	--	13,380,986	188,440	13,413,645	(100%)
Genessee	--		293,610	13,707,255	
Orleans	--		186,525	13,893,780	
Cattaraugus	--		408,330	14,302,110	
Chautauqua	--	13,380,986	736,525	15,038,635	
Erie	985,285	14,366,271	641,030	15,679,665	
Niagara	160,919	14,527,190	374,005	16,053,670	

west to east, this means that portions of green counties that are southwest to northwest of the direct-effects area are likely to have probable fallout doses much lower than indicated at the county centroid.

Conversely, if fallout data at the MCD level were available in white counties, those not identified at high fallout risk, it is likely that some MCDs would be noted downwind or east of the smaller direct-effects areas that should not be used for hosting. In regions such as the Northeast Corridor, where the main direction of relocation is to the west away from the seaboard, the gain in conveniently located areas for commuting to the big cities is likely to far outweigh the loss of some hosting space in outlying risk counties.

In the Northeastern planning region, special fallout calculations are available for the relevant MCDs in green counties. Calculations for other counties of interest throughout the country are underway. The planning team should submit a request through the DCPA Regional Director for such calculations for those fallout risk counties that are important to their planning problem. The population of MCDs with a probable dose less than 10,000 R should be multiplied by the applicable hosting ratio and added to the hosting capacity.

As an example, Table 13 shows the effect of an adjustment in hosting capacity in the New York planning area, where it was found that the MCDs not at blast risk in Westchester and Rockland Counties (and some in Suffolk County on Long Island) had probable doses substantially less than the 10,000 R criterion. As a result, Dutchess County was not needed for hosting key workers and families, the average travel distance moved from Otsego County to Saratoga County, and the maximum travel distance moved from Wyoming County to Steuben County, which, coincidentally, was the 100% location when a hosting ratio of 6 was used with the unadjusted risk population. Actually, since the relocatees assigned to Steuben County most likely would originate from Syracuse or Albany, the New York maximum distance is probably east of Steuben County.

Of greater consequence, perhaps, is the fact that consideration of fallout doses at the MCD level of detail allowed the hosting of over 1 million people inside the key cordon for the New York area. This reduction in demand on the transportation system will have a substantial impact on the timeliness of relocation in the final transportation analysis.

In Table 13, the summation has been terminated at Steuben County, since the earlier general allocation demonstrated that there is ample hosting space for Rochester and Buffalo to the west.

Table 13

SECOND ADJUSTMENT FOR TENTATIVE PLANNING AREA B AT HOSTING RATIO OF FIVE

(Population adjusted for Blast and Fallout Risk)

County	Risk Pop.	Cum. Risk Pop.	Host Cap.	Cum. Host Cap.	
Suffolk	1,061,628	1,061,628	148,000	148,000	
Nassau	1,428,838	2,490,466		148,000	
Queens	1,986,473	4,476,939		148,000	
Kings	2,602,012	7,078,951		148,000	
Richmond	295,443	7,374,394		148,000	
New York	1,539,233	8,913,627		148,000	
Bronx	1,471,701	10,385,328		148,000	
Westchester	750,901	11,136,229	717,000	865,000	
Rockland	191,900	11,328,129	190,100	1,055,100	
Putnam	--		283,480	1,338,580	
Orange	--		1,102,790	2,441,370	(20%)
Dutchess	--		1,111,475	3,552,845	
Ulster	--		706,205	4,259,050	
Sullivan	--		262,900	4,521,950	
Columbia	--		257,595	4,779,545	
Greene	--		165,680	4,945,225	
Delaware	--	11,328,129	223,590	5,168,815	
Wayne, PA	5,254	11,333,383	121,635	5,290,450	
Rensselaer	128,698	11,462,081	119,060	5,409,510	
Albany	277,989	11,740,070	38,145	5,447,655	
Schoharie	--	11,740,070	123,750	5,571,405	
Schenectady	157,179	11,897,249	19,000	5,590,405	
Montgomery	--	11,897,249	279,415	5,869,820	
Saratoga	35,485	11,932,734	430,965	6,300,785	(50%)
Fulton	--	11,932,734	263,185	6,563,970	
Herkimer	10,831	11,943,565	283,005	6,846,975	
Otsego	--	11,943,565	280,905	7,127,880	
Chenango	--	11,943,565	231,840	7,359,720	
Broome	91,338	12,034,903	652,385	8,012,105	
Susquehanna, PA	--		171,720	8,183,825	
Warren	--		247,010	8,430,835	
Hamilton	--	12,034,903	23,570	8,454,405	
Oneida	216,754	12,251,657	281,415	8,735,820	
Madison	29,421	12,281,078	167,215	8,903,035	
Cortland	--		229,470	9,132,505	
Tioga	--		232,565	9,365,070	
Lewis	--	12,281,078	118,220	9,483,290	
Oswego	19,277	12,300,355	408,100	9,891,390	
Onandaga	472,185	12,772,540		9,891,390	
Cayuga	--		387,195	10,278,585	
Tompkins	--		384,395	10,662,980	
Chemung	--		507,685	11,170,665	
Seneca	--		175,415	11,346,080	
Schuyler	--		83,685	11,429,765	
Wayne	--		397,020	11,826,785	
Ontario	--		394,245	12,221,030	
Yates	--		99,155	12,320,185	
Steuben	--	12,772,540	497,730	12,817,915	(100%)

SUMMATION DISCONTINUED

Fallout Shelter Considerations

At this point in regional planning, it is desirable to evaluate the fallout risk throughout each tentative planning area with a view toward reducing the amount and quality of fallout shelter that would be required in subsequent operational plans. In general, crisis relocation substantially reduces the overall fallout risk to the population. This reduction is to be expected because the people being relocated are being moved to locations that are more distant and often upwind from the assumed attack. The latter condition is most true for the eastern seaboard cities and least true for California. In the Midwest, choices can be made in selection of host counties that will minimize the fallout risk after relocation. To a greater or less degree, this can be done in all densely populated areas.

The ADAGIO printout lists a probable dose for each county. However, the listed dose does not adequately indicate the fallout protection factors that might be required in a given county. While the dose will be less than the tabulated value 50% of the time, there is a 50-50 chance that the dose will be greater than the listed value. In many counties there is at least a 50-50 chance that the dose will exceed 4,000 R. It is in these counties that the fallout risk to the relocated population will be the greatest and provision of adequate fallout protection will be the most difficult.

The general rule for providing fallout shelter would be to strive for the highest protection factors that can feasibly be developed through shelter improvement and expedient shelter construction. However, for many building types, it is not feasible to add sufficient shielding to improve the protection afforded by the existing structure much beyond PF-40. As a result, in host counties with probable doses greater than 4,000 R, it may be necessary to plan to construct expedient fallout shelters, in addition to upgrading congregate care and other facilities.

About one-half a cubic yard of dirt will be required for each shelter space produced by improving existing facilities. About two cubic yards of dirt must be moved for each expedient (trench type) shelter space. Expedient shelter construction not only requires more materials (dirt, shoring, etc.) but also requires more specialized earthmoving equipment. Thus, expedient shelter construction requires substantially more effort and resources to provide fallout protection than upgrading.

The feasibility of providing adequate and sufficient fallout shelter spaces for the relocated population will depend on:

The fallout risk in the host county.

The allocation formula used (congregate care space per evacuee or the equivalent hosting ratio).

The availability of congregate care and other facilities that can be upgraded, as shown by the Host Area Survey.

The availability of suitable earthmoving equipment.

Of the above factors, only the allocation formula is subject to substantial modification by the regional planning team. Therefore, the planning team should examine alternative allocation formulas, which consider the fallout risk in host counties, to determine if they can reduce the effort required to provide sufficient and adequate fallout shelter spaces without overtaxing the transportation system or hosting capacities.

Alternative A - No Hosting in Counties with Substantial Fallout Risk[1]

The first and obvious alternative would be to adjust the general allocation to exclude host counties where the ADAGIO printout indicates there is at least a 50-50 chance that the dose will be more than some value--e.g., 7,000 R or 4,000 R. The resident populations in such counties would stay in place. The advantage of this alternative is that it would place less stress on the existing shelter facilities. It would, however, be necessary to increase the number of evacuees allocated to other host counties where the fallout risk might be lower, and there would be increased transportation difficulties. The planning team should determine whether this alternative is feasible and worthwhile in their planning area.

Alternative B - Vary Hosting Ratio Inversely With Fallout Risk

A second alternative is to use all potential host counties but to adjust the allocation so that fewer evacuees are allocated to host counties where the fallout risk is above the average. The resident population of all host counties would remain in place, as would the resident population of high fallout risk counties.

One version of this alternative would be to follow this procedure:

a. List the counties in the planning area alphabetically by State as they are in the printout on a work sheet. Copy down the probable fallout dose for each county from the first line of each county listing. For counties over 10,000 R, use the weighted average of the doses for host MCDs, if MCD data is

available. If not or if no MCDs suitable for hosting exist, cross the green counties off the list.

b. Cross off the list all counties that are entirely at risk; that is, that have no hosting capacity irrespective of fallout level. The remaining counties are the potential host counties. Search the list for the one with the highest probable dose. Mark it with the figure (1). Find the next highest; mark it (2), and so on until the list has been ranked from highest to lowest in terms of fallout dose.

c. Prepare a work sheet similar to Table 14 in which the host counties are listed in order of rank, from highest probable dose to lowest. Enter the appropriate hosting capacity for each county based on previous adjustments. Then, sum the hosting capacities as in doing a general allocation.

d. Divide the final figure of cumulative hosting capacity by 3. Search down the list of counties to the point where the cumulative hosting capacity is about equal to this 1/3 of total host capacity; draw a line between the county just below and just above the required value. Double the search value, so it equals 2/3 the total hosting capacity. Search further down the list and place a mark between the two counties on either side of this value. This list has now been divided into three groups of approximately equal hosting capacity.

e. In the final column of the work sheet, enter a revised hosting capacity that is one-half the current capacity for the top group of counties and one and one-half times the current capacity for the low group counties. Leave the middle group of counties unchanged. Do a revised general allocation using the revised hosting capacities and compare with previous allocations.

The effect of this procedure is to increase hosting ratios to 1.5 times the average in counties where the fallout risk is lowest and to decrease the hosting ratios to half the average in the host counties where the fallout risk is greatest. If the average hosting ratio is 5, as we have been using for the Northeast Corridor, hosting ratios would vary from 7.5 in low fallout-risk counties to 2.5 in higher risk counties. Expressed in terms of housing allocations, the space allocation would range from 13 square feet in low risk counties to 40 square feet in high risk counties, the intermediate group remaining at 20 square feet.

Table 14

FALLOUT RISK ADJUSTMENT IN PLANNING AREA B AT AVERAGE HOSTING RATIO OF FIVE

County	F.O. Dose	Host Cap.	Cum. Host Cap.	Adj. Host Cap.
Madison	6657	167,215	167,215	83,608
Renssalaer	6504	119,060	286,275	59,530
Schenectady	5833	19,000	305,275	9,500
Albany	5750	38,145	343,420	19,072
Saratoga	5601	403,965	747,385	201,982
Rockland	5100	190,100	937,485	95,050
Lewis	3837	118,220	1,055,705	59,110
Niagara	3745	374,005	1,429,710	187,002
Schoharie	3570	123,750	1,553,460	61,875
Oneida	3522	281,415	1,834,875	140,708
Herkimer	3484	283,005	2,117,880	141,502
Erie	3409	641,030	2,758,910	320,515
Monroe	3317	517,355	3,276,265	258,678
Orleans	3287	186,525	3,462,790	93,262
Westchester	3050	717,000	4,179,790	358,500
Broome	2966	652,385	4,832,175	326,192
Montgomery	2894	279,415	5,111,590	139,707
Fulton	2843	263,185	5,374,775	131,592
Hamilton	2617	23,570	5,398,345	11,785
Columbia	2568	257,595	5,655,940	128,798
Wyoming	2545	188,440	5,844,380	
Genessee	2523	293,610	6,137,990	
Otsego	2494	280,905	6,418,895	
Warren	2463	247,010	6,665,905	
Chautauqua	2457	736,525	7,402,430	
Greene	2298	165,680	7,568,110	
Oswego	2205	408,100	7,976,210	
Livingston	2200	270,205	8,246,415	
Cattauraugus	2076	408,330	8,654,745	
Suffolk	2000	148,000	8,802,745	
Allegany	1970	232,290	9,035,035	
Wayne, PA	1949	121,635	9,156,670	
Ontario	1940	394,245	9,550,915	
Wayne	1897	397,020	9,947,935	
Chenango	1882	231,840	10,179,775	
Cortland	1862	229,470	10,409,245	
Sullivan	1757	262,900	10,672,145	
Delaware	1739	223,590	10,895,735	
Cayuga	1712	387,195	11,282,930	
Jefferson	1711	442,540	11,725,470	663,810
Ulster	1646	706,205	12,431,675	1,059,308
Seneca	1628	175,415	12,607,090	263,122
Yates	1589	99,155	12,706,245	148,732
Tioga	1588	232,565	12,938,810	348,848
Orange	1522	1,102,790	14,041,600	1,654,185
Susquehanna, PA	1494	171,720	14,213,320	257,580
Dutchess	1486	1,111,475	15,324,795	1,667,212

Table 14 (Continued)

County	F.O.Dose	Host Cap.	Cum. Host Cap.	Adj. Host Cap.
Putnam	1462	283,480	15,608,275	425,220
Steuben	1447	497,730	16,106,005	746,595
Schuyler	1350	83,685	16,189,690	125,528
Chemung	1350	507,685	16,697,375	761,528
Tompkins	1332	384,395	17,081,770	576,592

Table 15 shows the effect of using the revised hosting capacities of Table 14 in a revised general allocation in the New York planning area. The most adverse impact is to reduce by half the hosting capacity in Westchester and Rockland Counties and thus increase the traffic across the key cordon. In effect, key workers and their families are hosted at 40 square feet in these counties to ease the fallout protection burden and hosted at 13 square feet per person in Putnam and Orange Counties where the fallout risk is quite low. Indeed, the fallout risk in the nearby counties up the Hudson Valley is so low that far greater numbers of New Yorkers are hosted than before. As a consequence, the average relocation distance moves from Saratoga County to Sullivan County, to a new value of about 110 miles. On the other hand, counties partly at blast risk in the Albany and Binghamton areas have been given decreased hosting capacity, forcing their populations to move further. Hence the maximum relocation distance remains in the vicinity of Steuben County.

It will be noted in Table 14 that there are no host counties in the New York planning area with a probable dose above 7000 R. There are, however, six counties with a combined hosting capacity of 937,485 that have probable doses above 4000 R. Thus, an attractive alternative for this planning area would be to plan not to host relocatees in these counties. If the 937,485 spaces lost by this decision were spread among the counties in the lower third of the list, the hosting ratio in these counties would be increased from 5 to a little less than 6. It can be seen that there are many options available to the regional planners in most instances.

One of the difficulties that may be encountered in attempting to take into account fallout risk is that nearby counties needed to house key workers and their families may be among those with higher than average prospective fallout doses. Deleting these or reducing their hosting ratios may bring the feasiblity of commuting the essential workforce into question. This matter must be examined carefully in every case. In extreme cases, the job of providing high-quality fallout shelter must be accepted as part of the plan for maintaining essential functions in the large risk areas. Sometimes, however, adjustments can be made in the planning areas or non-highway modes, such as air lift, can be brought into the commuting plan.

Fallout risk adjustments can be readily accommodated in the Midwest planning region. In the Northeast, significant problems arise only in the Boston area. In California, however, the average hosting ratio is so high that the flexibility in allocations is somewhat reduced. California has an adjusted risk population of over 17 million. Assuming that green counties are denied to hosting (MCD fallout data is not yet available), the required hosting ratio is 7.6 relocatees per host county

Table 15

TENTATIVE PLANNING AREA B AT HOSTING RATIO OF FIVE, MODIFIED
(Population adjusted for Blast Risk)
(Hosting adjusted for Fallout Risk)

County	Risk Pop.	Cum. Risk Pop.	Adj. Host Cap.	Cum. Host Cap.	
Suffolk	1,061,628	1,061,628	148,000	148,000	
Nassau	1,428,838	2,490,466		148,000	
Queens	1,986,473	4,476,939		148,000	
Kings	2,602,012	7,078,951		148,000	
Richmond	295,443	7,374,394		148,000	
New York	1,539,233	8,913,627		148,000	
Bronx	1,471,701	10,385,328		148,000	
Westchester	750,901	11,136,229	358,500	506,500	
Rockland	191,900	11,328,129	95,050	601,550	
Putnam	--		425,220	1,026,770	
Orange	--		1,654,185	2,680,955	(20%)
Dutchess	--		1,667,212	4,348,167	
Ulster	--		1,059,308	5,407,475	
Sullivan	--		262,900	5,670,375	(50%)
Columbia	--		128,798	5,799,173	
Greene	--		165,680	5,964,853	
Delaware	--	11,328,129	223,590	6,188,443	
Wayne, PA	5,254	11,333,383	121,635	6,310,078	
Rensselaer	128,698	11,462,081	59,530	6,369,608	
Albany	277,989	11,740,070	19,072	6,388,680	
Schoharie	--	11,740,070	61,875	6,450,555	
Schenectady	157,179	11,897,249	9,500	6,460,055	
Montgomery	--	11,897,249	139,707	6,599,762	
Saratoga	35,485	11,932,734	201,982	6,801,744	
Fulton	--	11,932,734	131,592	6,933,336	
Herkimer	10,831	11,943,565	141,502	7,074,838	
Otsego	--	11,943,565	280,905	7,355,743	
Chenango	--	11,943,565	231,840	7,587,583	
Broome	91,338	12,034,903	326,192	7,913,775	
Susquehanna, PA	--		257,580	8,171,355	
Warren	--		247,010	8,418,365	
Hamilton	--	12,034,903	11,785	8,430,150	
Oneida	216,754	12,251,657	140,708	8,570,858	
Madison	29,421	12,281,078	83,608	8,654,465	
Cortland	--		229,470	8,883,935	
Tioga	--		348,848	9,232,784	
Lewis	--	12,281,078	59,110	9,291,894	
Oswego	19,277	12,300,355	408,100	9,699,994	
Onandaga	472,185	12,772,540		9,699,994	
Cayuga	--		387,195	10,087,189	
Tompkins	--		576,592	10,663,781	
Chemung	--		761,528	11,425,309	
Seneca	--		263,122	11,688,431	
Schuyler	--		125,528	11,813,959	
Wayne	--		397,020	12,210,979	
Ontario	--		394,245	12,605,224	
Yates	--		148,732	12,753,956	
Steuben	--	12,772,540	746,595	13,500,551	(100%)

SUMMATION DISCONTINUED

resident. Potential hosting space in Nevada and Arizona might reduce this ratio somewhat. In addition to 12 green counties where no hosting would be permitted unless MCD fallout data so indicated, there are seven counties with a probable dose over 7000 R. If the hosting that would have been planned in these counties were spread uniformly over the remaining host counties, the resulting hosting ratio would be approximately 10. As noted in the Introduction, this ratio corresponds to a housing allocation of 10 square feet per person, the same as the fallout shelter allocation. Alternatively, half the host capacity in the 15 counties with probable doses above 4000 R could be shifted to the remaining counties without exceeding a hosting ratio of 10. Both MCD fallout data and survey data on congregate care space are essential to good relocation planning in the densely populated California planning region.

Defining the Planning Area

The planners are encouraged to explore all reasonable alternatives for the adjustment of risk populations and the modification of hosting capacities using tentative planning area boundaries and the relatively simple general allocation procedure. Results among adjacent planning areas and throughout the planning region should be compared at each step for clues as to possible changes that would provide better balance between planning areas. When such changes are identified, they should be tested by modifying the general allocations. It should be recalled that commuting, average, and maximum relocation distances obtained in a general allocation are not precise. In general, they are somewhat larger than those for any particular risk area resulting from a detailed allocation designed to balance the relocation distances among risk areas. Nonetheless, the general allocation is adequate for adjusting risk and host populations and capacities and for identifying reasonable planning area boundaries.

In the general allocation process, it may be possible to identify ways that planning areas created for the large cities can be subdivided further. For example, it would be noted that the many medium-sized risk areas in Connecticut and western Massachusetts tend to flow naturally northward in western New England rather independently of the Boston-Providence complex. Subdividing New England into eastern and western planning areas not only simplifies the allocation process but also ensures better balance and a more efficient transportation analysis. To subdivide a planning region, a trial boundary is established along county lines and parallel general allocations run to evaluate the balance. Transportation routes are then evaluated and separate cordon analyses performed. In the recent feasibility study of the Northeast Corridor relocation problem, not only was New England subdivided but also New Jersey-Pennsylvania was divided into a northern and southern

planning area. The latter subdivision was not done until other balancing changes had been accomplished: two additional Pennsylvania counties were added to the New York planning area and Baltimore relocatees were removed from western Pennsylvania and reallocated into the Shenandoah valley of Virginia. The resulting subdivision permitted separate consideration of the large risk population in northeast New Jersey from the situation in the Southern New Jersey and Philadelphia areas. Figure 7 shows the final planning areas selected in the study.

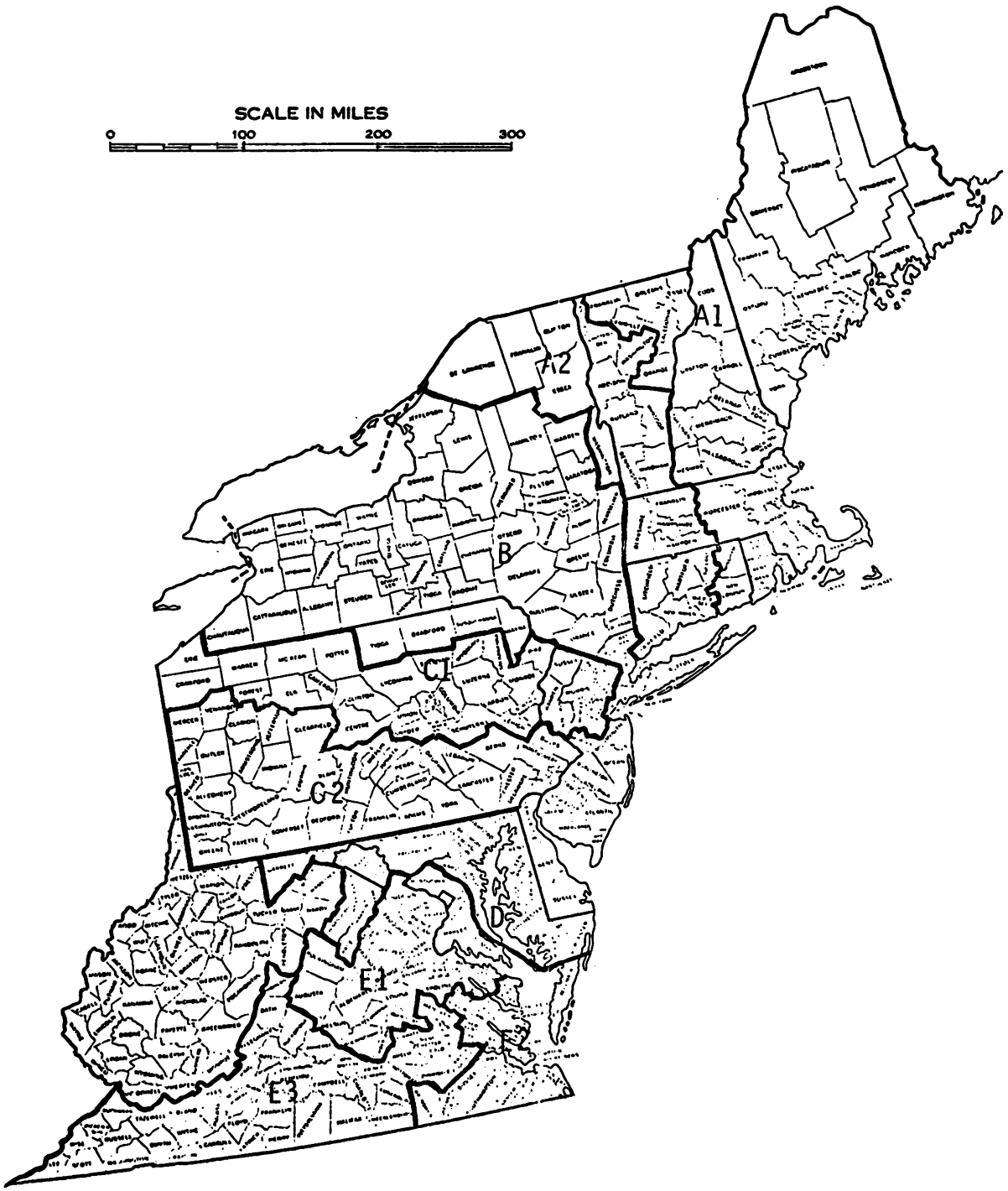


Figure 7 FINAL PLANNING AREAS AND SUBAREAS

Note to Chapter 6

1. Hosting ratios should not be established as a function of the fallout levels alone. Existing and potential fallout protected spaces need to be considered in relation to the demand for such spaces commensurate with the fallout intensities projected for the area.

7. DETAILED TRANSPORTATION ANALYSIS

In each planning area there will be a unique set of available transportation resources and capacity constraints, and for each general allocation being considered, there will be a set of transportation requirements. A detailed analysis of the transportation problem is necessary to provide the planning team with the basis for selecting the most suitable way of matching the available transportation resources to the transportation requirements posed by the general allocation. A detailed transportation analysis also provides the basis for judgments regarding the practicability of alternative general allocations. The results may largely influence the selection of a particular general allocation as the basis for making a detailed allocation of the residents of all risk areas to their appropriate host areas.

At this stage of the planning process, it is necessary to analyze transportation requirements, available resources, and capacity constraints to a greater level of detail than was necessary in the preliminary transportation analysis (Chapter 3) and the assessment of transportation capacity (Chapter 5). Transportation problems associated with relocation from the large risk area should be examined in detail. Transportation problems associated with the several smaller risk areas that are in the pattern of relocation flow should also be examined to the level of detail necessary, to avoid having the smaller risk areas preempt transportation resources needed for the overall relocation movement.

In performing the detailed analysis, the planning team will have to exercise considerable judgment especially in planning areas where the capacity of normally available resources is overtaxed by by crisis relocation transportation requirements. Usually it will be necessary to derive a series of trial solutions and to compare the trial solutions with the requirements posed by the general allocation in order to identify the mix of highway and non-highway modes that most clearly satisfies the relocation transportation requirements for the large risk area and the total planning area.

At this stage of the planning process, it is important to use adjusted risk and host population data and to use transportation planning factors that reflect the actual conditions in the planning area rather than using typical planning factors that were sufficient in preliminary stages.

Transportation Operating Situations

To reduce the complexity of the detailed analysis, it is convenient to employ a concept of transportation operating situations (TROS) illustrated by the matrix in Table 16. The matrix identifies nine TROS, each of which is defined by the combination of the

Table 16

TRANSPORTATION OPERATING SITUATIONS

CAPACITY OF RELOCATION SYSTEM	AVAILABILITY OF FIRST AUTOS: 100%* HIGH	90%* MARGINAL	75%* LOW
EXCESS — 1.5-Day**	(1)	(2)	(3)
MARGINAL — 3-Day**	(4)	(5)	(6)
SEVERE SHORTAGE	(7)	(8)	(9)

*Percent of risk population that can be relocated by first autos.

**Time required to relocate risk populations.

availability of first autos in the risk area and the capacity of the highway system leading from the risk area.

Availability of first autos is subdivided into three classes:

- High indicates that greater than 90 percent of the risk population has access to a first auto.
- Marginal indicates that between 75 percent and 90 percent of the risk population has access to a first auto.
- Low indicates that less than 75 percent of the risk population has access to a first auto.

The capacity of the highway system is expressed in terms of period of time required to relocate the risk population using automobiles.

- Excess means less than 1-1/2 days.
- Marginal means between 1-1/2 and 3 days.
- Severe shortage means that more than 3 days would be required.

The nine situations are numbered sequentially in the order of increasingly difficult transportation problems.

To use the TROS matrix, the planning team must first determine the availability of first autos (Chapter 3) and the capacity of the highway systems (Chapter 5). These results in combination identify which TROS applies to the risk area of concern. At this point, the planning team can make preliminary judgments regarding the mix of relocation transportation modes and traffic controls that would be appropriate for relocation from the risk area of concern. The matrix in Table 17 is presented to assist the team in making these preliminary judgments.

For risk areas where there is excess highway capacity (TROS 1, 2, 3), the planning team's major problem will concern the movement of carless persons. Second autos and buses may be in sufficient supply to solve this problem. However, as noted in Chapter 5 under capacity factors, buses take up more room on the highway and round trips may prove necessary. Therefore, the highway capacity and the time required for relocation should be recalculated to ensure that the capacity of the relocation system does not become marginal because of the use of buses. The use of non-highway modes for some of the carless may prove necessary in TROS 3.

For risk areas where the highway capacity is marginal (TROS 4, 5, 6), the planning team's major problem will concern measures to avoid underutilization of the system and avoid congestion. Designat-

Table 17

PLANNING FOR TRANSPORTATION OPERATING SITUATIONS

CAPACITY OF RELOCATION SYSTEM	AVAILABILITY OF FIRST AUTOS: 100%* HIGH	90%* MARGINAL	75%* LOW
EXCESS	(1) Normal Highway Lane Control Patrol Highways FIRST AUTOS SECOND AUTOS	(2) Normal Highway Lane Control Patrol Highways FIRST AUTOS SECOND AUTOS BUSES	(3) Normal Highway Lane Control Patrol Highways FIRST AUTOS SECOND AUTOS BUSES AIRCRAFT
1.5-Day** MARGINAL	(4) Some Freeways Outbound Only Closely Manage Traffic FIRST AUTOS Some SECOND AUTOS Some BUSES	(5) Some Freeways Outbound Only Closely Manage Traffic FIRST AUTOS Some SECOND AUTOS BUSES AIRCRAFT PASSENGER TRAINS	(6) Some Freeways Outbound Only Closely Manage Traffic FIRST AUTOS No SECOND AUTOS BUSES AIRCRAFT PASSENGER TRAINS TRUCKS
3-Day** SEVERE SHORTAGE	(7) Exploit Minor Roads All Freeways Outbound Total Traffic Control FIRST AUTOS--3 or more passengers NO SECOND AUTOS ALL BUSES AIRCRAFT To Other Areas FREIGHT & PASSENGER TRAINS ALL WATER MODES (Change rules, if necessary)	(8) Exploit Minor Roads All Freeways Outbound Total Traffic Control FIRST AUTOS--3 or more passengers DISPLACE SOME FIRST AUTOS AND REPLACE WITH BUSES AND TRUCKS No SECOND AUTOS AIRCRAFT To Other Areas FREIGHT & PASSENGER TRAINS ALL WATER MODES (Change rules, if necessary)	(9) Exploit Minor Roads All Freeways Outbound Total Traffic Control FIRST AUTOS--4 or more passengers DISPLACE FIRST AUTOS AS NEEDED TO MAXIMIZE USE OF BUSES AND TRUCKS No SECOND AUTOS AIRCRAFT To Other Areas FREIGHT & PASSENGER TRAINS ALL WATER MODES (Change rules, if necessary)

*Percent of risk population that can be relocated by first autos.

**Time required to relocate risk populations.

ing some freeways as outbound only and closely managing traffic will be required. If the availability of "first autos" is marginal (TROS 5) or low (TROS 6), increased reliance on buses and trucks rather than "second autos," and increased reliance on non-highway modes will be necessary. In these two situations, the planning team will have to devise a relocation system with an appropriate mix of highway and non-highway components; recalculate system capacity; and determine a revised value of the time required for relocation. Several trials may be necessary.

For large risk areas, often there will be a severe shortage of highway capacity (TROS 7,8,9). The planning team's major problem will concern measures to reduce the time required for relocation. The use of non-highway transportation modes and measures to increase highway system capacity will be of increased importance. Conversion of freeways to one-way outbound, wherever possible, displacing first autos by buses and trucks, and strong traffic control measures will be needed. Also, it will be necessary to exploit the use of minor roads (including roads from smaller risk areas to avoid situations where small risk areas would preempt major highways in the vicinity). For these situations, the planning teams will have to recalculate the relocation system capacity for the chosen mix of system components and determine a revised value of the time required for relocation. In most cases, several iterations will be required to derive the best mix of system components and the minimum time required for relocation.

For some large risk areas, it may not prove feasible to devise a relocation system that will accomplish relocation within the allowable three-day period. In such cases, the planning team should identify alternatives that would reduce the dimensions of the problem (use of fallout risk areas for hosting, redefinition of blast risk criteria, etc.) and seek policy guidance from state and federal authorities.

Large Risk Area First

The detailed transportation analysis should begin with the largest risk area in the planning area. This is because the large risk area will determine the general pattern of relocation flow, and it is in the large risk areas that the transportation requirements will be the greatest in comparison to the transportation capacity. The first step in the analysis is to determine which transportation operating situation applies to the risk area of concern. This is done by repeating the first auto analysis using the adjusted risk and host population data, and by repeating the cordon technique to estimate the automobile capacity of the highway networks leading from the risk area. Having determined the TROS, the planning team should refer to Table 17 and select a mix of highway and non-highway modes for detailed analysis.

Non-Highway Modes

In most large risk areas the use of non-highway transportation modes must be planned for because of the number of carless people and shortages in highway capacity. In such areas first consideration should be given to determining the numbers of carless people that can be relocated by non-highway modes, thereby reducing the number of persons that will require highway transportation. This will require a detailed analysis of the availability and potential capacity of rail, water, and air transportation systems serving the area. Preliminary planning factors for these systems have been given in Chapter 3. At this stage of the planning process, the planning team should consult with the appropriate officials of public and private agencies that operate these transportation systems, and with organizations such as the National Defense Transportation Association (NDTA). The key officials and operators of the transportation systems must participate in the planning process if credible and potentially effective crisis relocation plans are to be developed. Their guidance is needed to replace the preliminary planning factors with realistic planning factors that reflect the actual inventory and the potential capacities of these systems. Their guidance will also be needed regarding operational matters such as scheduling, controlling traffic, getting people to the terminal and distributing them on arrival in the host area, etc. These operational matters should be discussed to the extent necessary to ensure that the capacity factors used at this stage of the planning will prove feasible during an actual crisis. Detailed discussions regarding these operational matters should be deferred until such time as detailed risk county and host county plans are developed (Parts III and IV of the Basic Guidance).[1]

The revised planning factors should be used to make a detailed analysis of the numbers of carless people that can be relocated from the large risk area in a three-day period using non-highway modes of transportation. In some cases, the planning team will find that the potential capacity of available non-highway modes of transportation is greater than can be utilized. For example, it will usually be preferable to use highway transportation to relocate essential workers that must commute from nearby host areas back to the risk area. If the essential workers and their families constitute 20 percent of the risk population and the essential workers are proportionately distributed among the carless population, non-highway transportation modes can be used for only about 80 percent of the carless population.

Highway Modes

The number of people that must be relocated by highway modes is the total risk population minus the number that can be relocated

by non-highway modes. A detailed analysis is necessary to determine the adequacy of the highway system (vehicles and roads) in comparison to the numbers of persons to be relocated, and to identify the best combination of autos, buses, and trucks. This assessment must be based on realistic planning factors that reflect the actual characteristics of the highways and the actual inventory of vehicles, rather than on the typical planning factors that were presented in Chapter 5.

To derive the needed planning factors, the planning team should consult with State and local highway officials and representatives of the transportation industry serving the area. Their guidance will also be needed regarding the feasibility of measures that might be taken during a crisis to increase the vehicle carrying capacity of the highways--closing off intersections, allowing vehicles to use the shoulders of a road, making highways one-way outbound, using secondary routes, etc. Operational matters such as instituting lane controls, monitoring and controlling highway flows, and assisting disabled vehicles with tow trucks and service teams should also be discussed so as to insure that the capacity factors are realistic and attainable under crisis conditions. Detailed discussions regarding these operational matters should be deferred until such time as detailed risk county and host county plans are developed (Parts III and IV of the Basic Guidance).[2]

The detailed analysis of potential highway capacity is performed using the cordon technique described in Chapter 5 and using the revised planning factors discussed above. Usually a series of trial solutions will be required in order to identify the most suitable way of using the available highway networks and vehicles.

Buses and Trucks

First consideration should be given to determining the number of buses, and in some cases the number of buses and trucks, that would be required to relocate the remaining carless people--those that cannot be moved by non-highway modes and that do not have access to a first auto. This indicates the minimum number of outbound lanes that should be set aside for buses and trucks. Remember, if round trip patterns are used, each outbound lane must be matched by an inbound return lane. In most large risk areas, the inventory of buses will be sufficient to relocate the remaining carless people in three days or less. In some risk areas it may be necessary to augment the available buses by using a portion of the inventory of large trucks.

Automobiles

The next step is to determine the number of days that would be required for all first autos to cross the cordon, using only those

lanes that are not set aside for buses and trucks. This determination is made by the cordon technique, using the average number of persons per household as the average auto load.

If less than three days are required for all first autos to cross the cordon, the planning team can consider reducing the dependence on non-highway modes and on buses and trucks. In effect, the team has the option of using second autos and establishing minimum passenger loads for autos to carry a portion of those that would otherwise require buses, trucks, or non-highway modes. The time required to relocate the entire risk population is then recalculated for the chosen mix of highway and non-highway transportation modes and traffic controls. Often several trial solutions will be required to derive the most suitable way of using the available transportation resources.

If more than three days are required for all first autos to cross the cordon, the planning team should consider displacing some first autos by setting aside additional lanes for buses and trucks until the supply of large vehicles is exhausted. The time required to relocate the entire risk population is then recalculated for the chosen mix of highway and non-highway transportation modes and traffic controls. Often several trial solutions will be required to identify the most suitable way of using available transportation resources. In some cases, it may prove necessary to continue the relocation operation using both non-highway and highway systems for more than three days. In such cases, the planning team should seek policy guidance from appropriate State and DCPA Regional authorities.

Relocation Flow

When the detailed analysis of transportation from the large risk area is completed, the planning team should adjust the general allocation to correspond to the chosen mix of highway and non-highway modes. Procedures for adjusting the general allocation were given in Chapter 4.

The transportation problems posed by the adjusted general allocation should then be assessed to the level of detail necessary to be sure that the general allocation is practicable throughout the relocation flow. This assessment is made by repeating the cordon technique several times, with the cordon line drawn at progressively greater distances from the large risk area. For each repeated application of the cordon technique, the population in the relocation flow will be reduced by the numbers of persons that can be accommodated in intervening host areas, and will be increased by the population of any risk areas between the cordon lines.

The planning team must exercise care in specifying the transportation that will be used for relocation from outlying risk areas. For a considerable distance from the large risk area, it will often prove necessary to use secondary roads to relocate from smaller risk areas, and to reserve one-way outbound freeways for autos, buses, and trucks from the large risk area. Otherwise, vehicles from the smaller risk areas may interfere with the main relocation flow and reduce the overall highway capacity.

The series of trial solutions with the cordon line drawn at progressively greater distances should be continued until it is evident that the capacity of highways and secondary routes is more than sufficient to carry the population being relocated, and that measures such as one-way roads are no longer necessary.

Notes to Chapter 7

1. Planners are not required to adhere to an inflexible phased approach in developing their crisis relocation plans. Operations planning for the complex situations created by a crisis relocation may not effectively be accomplished by an incremental, linear, phased approach. Development of comprehensive crisis relocation plans may at times require parallel, coordinate, and concurrent planning techniques.

2. See Note 1, above.

8. DETAILED ALLOCATION PROCEDURES

The allocation procedures outlined in this chapter permit the risk population of each risk county to be assigned to specific host counties in such a way as to equalize highway travel distances among the various risk counties and to use the available transportation resources to the best advantage.[1] The procedures can also be used to evaluate the consequences of various allocation policies. Usually, a series of trial solutions are needed for these purposes. Often, several promising solutions will be developed for review by decision-makers.

While not unduly burdensome, a detailed allocation is more time-consuming than the general allocation procedure presented in Chapter 4. Therefore, the planner is encouraged to use the simpler procedure for much of the preliminary work. As has been seen, a great deal can be done in the way of defining planning areas, analyzing transportation resources, and evaluating highway capacities prior to engaging in the first detailed allocation. In particular, regional planners should have adjusted the risk populations and host capacities as outlined in Chapter 6 and decided on final planning area boundaries, prior to approaching a detailed allocation. With respect to planning areas, it will be advantageous to subdivide the planning region into as many planning areas as are justified by relocation flow, highway routes, and other factors in order to make the detailed allocation process less cumbersome than might otherwise be required.

Preparatory Steps

Two preparatory steps are needed to provide a basis for the detailed allocation. Once accomplished, new allocations based on various planning assumptions can be readily performed.

The first preparatory step is to prepare a highway mileage worksheet for the planning area. On a suitable columnar pad, lay out the names of the risk counties across the top, alloting a column to each. The host counties should be listed down the left-hand side of the worksheet. Counties having both risk population and hosting capacity are listed in both categories. It is important to attach the two-letter State designator to each county name, as neighboring States often have counties of the same name.

The order of listing of the risk and host counties is important so that the mileage worksheet will be consistent with the allocation worksheet discussed later. For this reason, the counties should be listed in order of their occurrence in the relocation flow. This is, of course, the same order in which they are listed in the general allocation procedure. Table 18 is an example mileage worksheet for the

Table 18

EXAMPLE MILEAGE WORKSHEET

Host Counties	Risk Counties: Fairfield CT	New Haven CT	Middlesex CT	Litchfield CT	Hartford CT	Tolland CT	Hampden MA	Hampshire MA	Berkshire MA	Chittenden VT	Clinton NY	Franklin NY	St. Lawrence NY
Fairfield CT	21	26	45	X	X	X	X	X	X	X	X	X	X
Litchfield CT	51	43	39	18	29	44	X	X	X	X	X	X	X
Hartford CT	69	61	57	18	28	27	X	X	X	X	X	X	X
Hampden MA	80	62	42	45	25	25	10	X	X	X	X	X	X
Hampshire MA	96	78	58	57	42	42	18	10	X	X	X	X	X
Berkshire MA	100	92	85	56	69	76	51	43	22	X	X	X	X
Franklin MA	115	97	77	77	61	61	37	20	X	X	X	X	X
Bennington VT	150	142	135	106	119	119	97	79	50	X	X	X	X
Windham VT	164	164	149	129	134	134	110	94	89	X	X	X	X
Washington NY	176	168	165	133	149	149	127	109	80	X	X	X	X
Rutland VT	193	185	170	149	154	154	130	113	108	X	X	X	X
Windsor VT	193	185	170	149	154	154	130	113	108	X	X	X	X
Addison VT	226	218	241	182	196	196	173	155	126	X	X	X	X
Essex NY	250	242	236	207	220	220	198	180	151	42	28	X	X
Washington VT	251	233	213	213	197	197	173	156	160	X	X	X	X
Chittenden VT	255	247	238	211	222	222	198	181	155	10	X	X	X
Clinton NY	284	276	270	241	254	254	232	214	185	76	10	X	X
Grand Isle VT	287	277	268	241	252	252	228	211	185	30	X	X	X
Franklin NY	321	313	311	278	296	296	274	256	227	105	59	16	X
St. Lawrence NY	326	318	316	283	301	301	279	261	232	142	96	37	15

western New England planning area. Note that the listing of risk counties begins with Fairfield County, Connecticut, and goes along the coast before listing the inland or northerly counties. Also, there are two Franklin and two Washington counties.

It is not necessary to estimate the distance between each pair of counties, since in most cases, relocation will not take place against the relocation flow. Therefore, before going further, it is useful to cross out each risk/host combination that represents a move in the wrong direction. Thus, in the example, Litchfield County would not move south to Fairfield County.

The tool used in determining the highway mileages to be entered in the distance worksheet is the Standard Highway Mileage Guide published by Rand McNally and Company, which has been provided as an augmentation of the Part I data package. The use of this guide is recommended rather than the use of other means, such as distance wheels and other highway maps, because the distances obtained are accurate and appropriate to routes that could be used by buses and tractor-trucks.

The Mileage Guide is a folio-sized book consisting of two basic parts: an extensive mileage table showing the distance from any "key point" to any other key point in the United States; and a set of maps showing the location of all key points, highways, and mileage along the routes between places. A list of rules for computing mileage in a standard way is given in the front of the volume. Very generally, the procedure is to determine the distance from the origin to the nearest key point in the trip direction, look up the distance between this key point and the key point closest to the destination in the table, and then add any mileage from the last key point to the actual destination. A rigorous application of the rules is quite laborious and not necessary for allocation purposes. A simplified procedure is outlined in the attachment to this chapter. As mileages are determined, these are entered into the appropriate block on the distance worksheet. Table 18 is an example of a completed worksheet.

The second preparatory step is to update the population input data and hosting capacities. While this step is not mandatory, it is good planning practice to work with the most current information. For example, the computer printouts that have been the basis for the general allocation procedure not only contain some errors but also are based on preliminary census data for 1970. In some counties, later census estimates may be available and should be used. Corrected final 1970 census counts for all other counties and MCDs are contained in the Bureau of Census Publications PCB(1)-A for the State or States of interest. Adjustments of blast and fallout risk populations should be made as described in Chapter 6. Similarly, survey data or predictions of congregate-care space should be incorporated where available.

The importance of adjusting the population was demonstrated during the recent feasibility study. Updating of the 1970 Census data added about one-quarter million persons to the total population of the Northeast Corridor planning region. Elimination of urban tentacles reduced the population at blast risk by about 750,000 persons. Use of fallout risk data at the MCD level decreased the number at fallout risk by 5 percent. While these are not large changes, they exert remarkable leverage on the relocation problem.

Preparing Allocation Worksheets

The next step is to prepare the worksheet to be used in making the allocation of population from each risk county to appropriate hosting capacity in the outlying host counties so that not only is the overall relocation travel distance a practical minimum but also the average and maximum travel distances for each risk county are balanced as well as possible with the travel distances for the others. The procedure described here is known as the "20 percent slice method." It is recommended as the basic method and should be done first. Modifications that may be compared with this method are discussed later in the chapter.

The allocation worksheet is used to record and prove out the actual allocation. An example is shown in Table 19 for the western New England planning area. The procedure for preparing the worksheet is as follows:

a. List the host counties in the first column, using the same order as in the mileage table. Keeping the two worksheets in the same order allows the planner to go directly from one to the other.

b. Enter the host capacity of the host counties in the adjacent column. The capacity can be based on a common hosting ratio, a variable ratio, congregate-care predictions, or survey results.

c. List the risk counties across the worksheet in the same order as on the mileage table, which was based on the relocation flow. Counties that contain both risk population and a hosting capacity are given both a column and a row.

d. Below each risk county listed, enter the number of people at risk, in thousands to the nearest hundred. These populations can be both adjusted and updated.

e. On the next line below the risk population, enter 20 percent of the risk population in the same units. This is the population "slice" that will be successively allocated during the allocation process. The first slice accounts for the critical work force that must be allocated so as to permit commuting to and from the risk area.

Table 19

EXAMPLE ALLOCATION WORKSHEET

	Risk Counties												
	Fairfield CT	New Haven CT	Middlesex CT	Litchfield CT	Hartford CT	Tolland CT	Hampden MA	Hampshire MA	Berkshire MA	Chittenden VT	Clinton NY	Franklin NY	St. Lawrence NY
Risk Population - -	750.3	744.9	71.3	94.3	815.4	79.2	456.1	80.3	80.4	83.1	45.0	1.5	25.9
20 Percent Slice --	150.1	149.0	14.3	18.9	163.1	15.8	91.2	16.1	16.1	16.6	9.0	0.3	5.2

Host Counties	Capacity
Fairfield CT	212.5
Litchfield CT	249.1
Hartford CT	6.5
Hampden MA	15.0
Hampshire MA	218.3
Berkshire MA	344.8
Franklin MA	296.0
Bennington VT	146.4
Windham VT	165.4
Washington NY	263.6
Rutland VT	263.2
Windsor VT	220.4
Addison VT	121.3
Essex NY	173.2
Washington VT	238.3
Chittenden VT	80.2
Clinton NY	139.8
Grand Isle VT	17.9
Franklin NY	212.0
St. Lawrence NY	430.7

This completes the preparation of the allocation work sheet. Note that counties in the planning area that have no risk population and are not to be used for hosting because of fallout risk are not shown on the allocation sheet.

Making the Allocation

The basic procedure for making an allocation using the 20 percent slice method is simple: Beginning with the first (left-hand) risk county on the allocation worksheet, allocate 20 percent of the risk population of that county to the nearest county or counties with available hosting capacity; do the same for each risk county in turn; return to the first risk county and allocate a second 20 percent slice; continue through the ordered list until 100 percent of all risk populations have been allocated. There are, however, two basic conditions to be observed in performing this iterated allocation. First, a risk county has prior rights to any hosting capacity within its own boundaries during the first 20 percent iteration that accounts for key workers. Second, outlying risk counties are not included in the iteration until the allocation of hosting capacity has passed beyond them, except, of course, for the key worker slice.

To keep track of the progress of the allocation, a running record should be kept. An example is given in Table 20 which shows the first 17 moves of the allocation in the western New England area, carrying the allocation through the 20 percent level. The first 10 moves involve those risk counties that have hosting capacity within their own boundaries. In all but two--Hartford, CT and Hampden, MA--the first 20 percent of the risk population can be hosted within the county with capacity to spare. On the eleventh move, the planner starts over with the leftmost risk county not yet having commuting space. It is New Haven County, which occupies the remaining space in Fairfield County and some space in Litchfield. (An X in the Host Column means that space in the host county has been exhausted.) Next, 20 percent of the Middlesex risk population is allocated to Litchfield (Move No. 13). Hartford occupies the remainder of the Litchfield capacity and sends its remainder to the next closest host county which, according to the distance worksheet, is Hampshire County, MA. Tolland and Hampden also use Hampshire County space to complete the first 20 percent allocation.

Note that in this allocation process, there is a continuing use of the numbers on the allocation worksheet pertaining to 20 percent slices, host capacities, and the distances in the mileage worksheet. A good highway map should be referred to, because there must be highway access between the risk and host counties. Also, a handheld calculator or its equivalent is almost a necessity in order to keep a running record of remaining capacity and remaining population to be relocated.

Table 20

EXAMPLE RUNNING RECORD SHOWING 20 PERCENT ALLOCATION

Move No.	Move	Risk	Host
1	Fairfield 150.1 to Fairfield	20% commute	62.4 left
2	Litchfield 18.9 to Litchfield	20% commute	230.2 left
3	Hartford 6.5 to Hartford	156.6 to go	X
4	Hampden 15.0 to Hampden	76.2 to go	X
5	Hampshire 16.1 to Hampshire	20% commute	202.2 left
6	Berkshire 16.1 to Berkshire	20% commute	328.7 left
7	Chittenden 16.6 to Chittenden	20% commute	63.6 left
8	Clinton 9.0 to Clinton	20% commute	130.8 left
9	Franklin NY 0.3 to Franklin NY	20% commute	211.7 left
10	St. Lawrence 5.2 to St. Lawrence	20% commute	425.5 left
11	New Haven 62.4 to Fairfield	86.6 to go	X
12	New Haven 86.6 to Litchfield	20% commute	143.6 left
13	Middlesex 14.3 to Litchfield	20% commute	129.3 left
14	Hartford 129.3 to Litchfield	27.3 to go	X
15	Hartford 27.3 to Hampshire MA	20% commute	174.9 left
16	Tolland 15.8 to Hampshire	20% commute	159.1 left
17	Hampden, MA 76.2 to Hampshire	20% commute	82.9 left

End 20 Percent Commute

It is recommended that the results of each iteration be entered into the allocation worksheet when the iteration is completed. Thus, at the end of Move No. 17, the allocations would be logged (in pencil) onto the allocation worksheet. An example is shown in Table 21. According to the running record, the hosting capacities in four counties (Hartford, Hampden, Fairfield, and Litchfield) are completely used up. Hence, as shown in Table 23, the allocations for these counties are summed up along the rows of the allocation worksheet and entered in the Proof Total column as a check against the accuracy of the running record.

After completing the 20 percent allocation, the planning team continues with the remaining allocations in 20 percent increments, until all the allocations are made. The running record is used throughout; Table 22 shows the example running record for the remainder of the allocation. A total of 70 moves is needed to complete the example allocation. After each risk county's population has been totally allocated, and the number entered in the allocation worksheets, a proof total is also entered. Table 23 shows the completed allocation for the example (Planning Area A2).

In some allocation moves, the judgment of the planner may be called into play to alter the procedure somewhat for good and sufficient reasons. An example occurs at Move No. 28 in Table 22. Fairfield County occupies the remaining space in Berkshire County with part of its 60 percent slice. The next closest available hosting space is a small residual in Hampshire County. Most of the remainder of the Fairfield slice must go to Bennington, VT. This means that all of the other coastal Connecticut counties must go farther. In the example, it was judged better for Fairfield to go only to Berkshire and Bennington and to split the smaller Middlesex slice between Hampshire and some Vermont county. A similar alteration may be observed at Move No. 35. Whether these judgments are correct or useful may be argued, but they are exhibited to illustrate that flexibility and judgment are likely to play a role in any allocation.

Note that in Move No. 51, there are three X's in the Host column of the running record for Addison County, VT (Table 22). This signifies that in this county there was a small residual capacity that the planner decided to ignore. This outcome is also reflected in the allocation worksheet (Table 23) where the proof total is 121,100 while the hosting capacity is given as 121,300. It did not make sense to send 200 people from another risk area to fill out Addison County. Similarly, the proof total for another county might have shown a slight overage in the assignment if not doing so would have meant sending a few hundred people to a different county. The planner should recognize this degree of flexibility in allocation and identify such decisions in the running record so that they may be distinguished from simple errors.

Table 21

EXAMPLE ALLOCATION WORKSHEET SHOWING
20 PERCENT ALLOCATION

	Risk Counties												
	Fairfield CT	New Haven CT	Middlesex CT	Litchfield CT	Hartford CT	Tolland CT	Hampden MA	Hampshire MA	Berkshire MA	Chittenden VT	Clinton NY	Franklin NY	St. Lawrence NY
Risk Population - -	750.3	744.9	71.3	94.3	815.4	79.2	456.1	80.3	80.4	83.1	45.0	1.5	25.9
20 Percent Slice --	150.1	149.0	14.3	18.9	163.1	15.8	91.2	16.1	16.1	16.6	9.0	0.3	5.2

Host Counties	Capacity												
Fairfield CT	212.5	150.1	62.4										
Litchfield CT	249.1		86.6	14.3	18.1	129.3							
Hartford CT	6.5					6.5							
Hampden MA	15.0						15.0						
Hampshire MA	218.3					27.3	15.8	76.2	16.1				
Berkshire MA	344.8									16.1			
Franklin MA	296.0												
Bennington VT	146.4												
Windham VT	165.4												
Washington NY	263.6												
Rutland VT	263.2												
Windsor VT	220.4												
Addison VT	121.3												
Essex NY	173.2												
Washington VT	238.3												
Chittenden VT	80.2									16.6			
Clinton NY	139.8										9.0		
Grand Isle VT	17.9												
Franklin NY	212.0											0.8	
St. Lawrence NY	430.7												5.2

Table 22

EXAMPLE RUNNING RECORD SHOWING REMAINDER OF ALLOCATION

Move No.	Move	Risk	Host
18	Fairfield 150.1 to Berkshire MA	40 % level	178.6 left
19	New Haven 82.9 to Hampshire MA	66.1 left to go	X
20	New Haven 66.1 to Berkshire MA	40 % level	112.5 left
21	Middlesex 14.3 to Berkshire MA	40 % level	98.2 left
22	Litchfield 18.9 to Berkshire MA	40 % level	79.3 left
23	Hartford 163.1 to Franklin MA	40 % level	132.9 left
24	Tolland 15.8 to Franklin MA	40 % level	117.1 left
25	Hampden 91.2 to Franklin MA	40 % level	25.9 left
26	Hampshire 16.1 to Franklin MA	40 % level	9.8 left
27	Berkshire 16.1 to Berkshire	40 % level	63.2 left
	End 40 Percent Except Chittenden, etc.		
28	Fairfield 63.2 to Berkshire MA	86.9 left to go	X
29	Middlesex 9.8 to Franklin MA	4.5 left to go	X
30	Fairfield 86.9 to Bennington VT	60 % level	59.5 left
31	New Haven 59.5 to Bennington VT	89.5 left to go	X
32	Middlesex 4.5 to Windham VT	60 % level	160.9 left
33	New Haven 89.5 to Windham VT	60 % level	71.4 left
34	Litchfield 18.9 to Windham VT	60 % level	52.5 left
35	Tolland 15.8 to Windham VT	60 % level	36.7 left
36	Hartford 36.7 to Windham VT	126.4 left to go	X
37	Hartford 126.4 to Washington NY	60 % level	137.2 left
38	Hampden 91.2 to Washington NY	60 % level	46.0 left
39	Hampshire 16.1 to Washington NY	60 % level	29.9 left
40	Berkshire 16.1 to Washington NY	60 % level	13.8 left
	End 60 Percent Except Chittenden, etc.		

Table 22 (continued)

Move No.	Move	Risk	Host
41	Fairfield 13.8 to Washington NY	136.3 left to go	X
42	Fairfield 136.3 to Rutland VT	80 % level	126.9 left
43	New Haven 126.9 to Rutland VT	22.1 left to go	X
44	New Haven 22.1 to Windsor VT	80 % level	198.3 left
45	Middlesex 14.3 to Windsor VT	80 % level	184.0 left
46	Litchfield 18.9 to Windsor VT	80 % level	165.1 left
47	Tolland 15.8 to Windsor VT	80 % level	149.3 left
48	Hartford 149.3 to Windsor VT	13.8 left to go	X
49	Hartford 13.8 to Addison VT	80 % level	107.5 left
50	Hampden 91.2 to Addison VT	80 % level	16.3 left
51	Hampshire 16.1 to Addison VT	80 % level	XXX
52	Berkshire 16.1 to Essex NY	80 % level	157.1 left
	End 80 Percent Except Chittenden, etc.		
53	Fairfield 150.1 to Essex NY	100%	7.0 left
54	New Haven 149.0 to Washington VT	100%	89.3 left
55	Middlesex 14.3 to Washington VT	100%	75.0 left
56	Litchfield 7.0 to Essex NY	11.9 left to go	X
57	Litchfield 11.9 to Chittenden VT	100%	51.7 left
58	Hartford 75.0 to Washington VT	88.1 left to go	X
59	Hartford 51.7 to Chittenden VT	36.4 left to go	X
60	Hartford 17.9 to Grand Isle VT	18.5 left to go	X
61	Hartford 18.5 to Clinton NY	100%	112.3 left
62	Tolland 15.8 to Clinton NY	100%	96.5 left
63	Hampden 91.2 to Clinton NY	100%	5.3 left
64	Hampshire 5.3 to Clinton NY	10.8 left to go	X
65	Hampshire 10.8 to Franklin NY	100%	200.9 left
66	Berkshire 16.1 to Franklin NY	100%	184.8 left
67	Chittenden 66.5 to Franklin NY	100%	118.3 left
68	Clinton 36.0 to Franklin NY	100%	82.3 left
69	Franklin NY 1.2 to Franklin NY	100%	81.1 left
70	St. Lawrence 20.7 to St. Lawrence NY	100%	404.8 left

Table 23

EXAMPLE ALLOCATION WORKSHEET SHOWING
COMPLETED ALLOCATION

		Risk Counties													
		Fairfield CT	New Haven CT	Middlesex CT	Litchfield CT	Hartford CT	Tolland CT	Hampden MA	Hampshire MA	Berkshire MA	Chittenden VT	Clinton NY	Franklin NY	St. Lawrence NY	
Risk Population - -		750.3	744.9	71.3	94.3	815.4	79.2	456.1	80.3	80.4	83.1	45.0	1.5	25.9	Proof
20 Percent Slice --		150.1	149.0	14.3	18.9	163.1	15.8	91.2	16.1	16.1	16.6	9.0	0.3	5.2	Total
Host Counties	**Capacity**														
Fairfield CT	212.5	150.1	62.4												212.5
Litchfield CT	249.1		86.6	14.3	18.9	129.3									249.1
Hartford CT	6.5					6.5									6.5
Hampden MA	15.0							15.0							15.0
Hampshire MA	218.3		82.9			27.3	15.8	76.2	16.1						218.3
Berkshire MA	344.8	213.3	66.1	14.3	18.9					32.2					344.8
Franklin MA	296.0			9.8		163.1	15.8	91.2	16.1						296.0
Bennington VT	146.4	86.9	59.5												146.4
Windham VT	165.4		89.5	4.5	18.9	36.7	15.8								165.4
Washington NY	263.6	13.8				126.4		91.2	16.1	16.1					263.6
Rutland VT	263.2	136.3	126.9												263.2
Windsor VT	220.4		22.1	14.3	18.9	149.3	15.8								220.4
Addison VT	121.3					13.8		91.2	16.1						121.1
Essex NY	173.2	150.1			7.0					16.1					173.2
Washington VT	238.3		149.0	14.3		75.0									238.3
Chittenden VT	80.2				11.9	51.7					16.6				80.2
Clinton NY	139.8					18.5	15.8	91.2	5.3			9.0			139.8
Grand Isle VT	17.9					17.9									17.9
Franklin NY	212.0								10.8	16.1	66.5	36.0	1.5		130.9
St. Lawrence NY	430.7													25.9	25.9
Proof Total		750.5	745.0	71.5	94.5	815.5	79.0	456.0	80.5	80.5	83.1	45.0	1.5	25.9	3328.5

When the allocation is complete, it will generally be found that the last county used is only partially filled and some counties may be too far away to be used at all. In the example allocation (Table 23), Franklin County, NY is only partially occupied and St. Lawrence County is not used at all, except for its own risk population. The complete allocation is proofed further by summing the columns to be sure that the risk populations are accounted for (bottom line of Table 23). Since the allocation dealt with five 20 percent slices, the totals will usually end in either a 5 or a zero, and not the exact risk population shown at the top of the allocation worksheet. This is generally sufficient for the purpose. If the planner desires, the last slice can be adjusted to produce the exact total, with small changes in the final allocation.

Computing Distances

The next step is to compute the average and maximum relocation distances for each risk county. The maximum distances, of course, come directly from the mileage worksheet for the last county to which the risk population is allocated. To obtain the average distance, a weighted average is usually calculated, as follows:

a. Equal Allocation Case

For some risk counties, it may turn out that each 20 percent slice went to a different host county, with no remainders. In the example in Table 23, this occurred in the case of Tolland County. In this circumstance of equal allocations, it is sufficient to add up the distances to the five host counties from the mileage worksheet and divide by five to obtain the average relocation distance.

b. Unequal Allocation Case

For most risk counties, the allocations will not be equal. For example, in Berkshire County, MA, there remained sufficient hosting capacity within the county when it became Berkshire's turn on the second iteration so that the first two slices were allocated within the county. Subsequent slices went to three other counties. For such cases, the numbers of people allocated to each county are multiplied by the travel distance, the products added together, and the total is divided by the proof total at the bottom of the allocation worksheet to give the weighted average.

Table 24 shows a completed allocation worksheet indicating average and maximum distances for each risk county. Also shown is the average commuting distance, obtained by calculating for the first slice only.

Table 24

EXAMPLE ALLOCATION WORKSHEET SHOWING RELOCATION DISTANCES

		Risk Counties													
		Fairfield CT	New Haven CT	Middlesex CT	Litchfield CT	Hartford CT	Tolland CT	Hampden MA	Hampshire MA	Berkshire MA	Chittenden VT	Clinton NY	Franklin NY	St. Lawrence NY	
Risk Population - -		750.3	744.9	71.3	94.3	815.4	79.2	456.1	80.3	80.4	83.1	45.0	1.5	25.9	Proof
20 Percent Slice --		150.1	149.0	14.3	18.9	163.1	15.8	91.2	16.1	16.1	16.6	9.0	0.3	5.2	Total
Host Counties	**Capacity**														
Fairfield CT	212.5	150.1	62.4												212.5
Litchfield CT	249.1		86.6	14.3	18.9	129.3									249.1
Hartford CT	6.5					6.5									6.5
Hampden MA	15.0							15.0							15.0
Hampshire MA	218.3		82.9			27.3	15.8	76.2	16.1						218.3
Berkshire MA	344.8	213.3	66.1	14.3	18.9					32.2					344.8
Franklin MA	296.0			9.8		163.1	15.8	91.2	16.1						296.0
Bennington VT	146.4	86.9	59.5												146.4
Windham VT	165.4		89.5	4.5	18.9	36.7	15.8								165.4
Washington NY	263.6	13.8				126.4		91.2	16.1	16.1					263.6
Rutland VT	263.2	136.3	126.9												263.2
Windsor VT	220.4		22.1	14.3	18.9	149.3	15.8								220.4
Addison VT	121.3					13.8		91.2	16.1						121.1
Essex NY	173.2	150.1			7.0					16.1					173.2
Washington VT	238.3		149.0	14.3		75.0									238.3
Chittenden VT	80.2				11.9	51.7					16.6				80.2
Clinton NY	139.8					18.5	15.8	91.2	5.3			9.0			139.8
Grand Isle VT	17.9					17.9									17.9
Franklin NY	212.0								10.8	16.1	66.5	36.0	1.5		130.9
St. Lawrence NY	430.7													25.9	25.9
Proof Total		750.5	745.0	71.5	94.5	815.5	79.0	456.0	80.5	80.5	83.1	45.0	1.5	25.9	3328.5
Distance-Average		138	139	121	112	123	129	117	108	100	86	49	16	15	
-Maximum		250	233	213	211	254	254	232	256	227	105	59	16	15	
-Commute		21	36	39	18	31	42	17	10	22	10	10	16	15	

Adjusting the Allocation

The allocation derived by the process described above is usually very nearly the best that can be devised. There are, however, three basic deficiencies, or areas of improvement, that should be investigated in consultation with State and local civil defense staffs to assure that the final allocation is as equitable as possible and can be implemented in the detailed planning phases. These three areas are:

(1) Improved equity in average and maximum travel distances.

(2) Reduced numbers of host counties assigned to particular risk areas.

(3) Adequacy of route capacities to handle the relocation traffic.

Improvements in the first two areas are often found to be interrelated, and to be associated with the larger risk populations. Note in Table 24 that New Haven County, CT has the highest average travel distance, 139 miles as opposed to the weighted average of 127 miles. It might be desirable to adjust the allocation so as to reduce the New Haven average and increase one or more of the low averages shown by Hampshire, Berkshire, and Chittenden Counties. Note also that New Haven is to send relocatees to nine different host counties. This means that in the detailed planning, the territory of New Haven County must be subdivided into nine districts that contain roughly the number of people allocated to each county and that have boundaries easily communicated to, and recognized by, the population so that they will know which host county to go to. This may not be practical. (Neighboring Fairfield County is allocated only six host counties and since there are three separate metropolitan areas in Fairfield County, there should be no difficulty in devising a practical public information plan.)

The outlying allocations in Table 24 may be re-examined from the point of view of reducing both the number of host counties and the average relocation distance for New Haven County. Note that New Haven has 22,100 people allocated to Windsor County, VT. If these 22,100 could be relocated to a closer-in host county where New Haven people are already assigned, both aspects could be improved. The obvious candidate is Berkshire County, MA, which has 40 percent of its population within its own boundaries. By adding the 22,100 to the New Haven assignment in Berkshire and moving 22,100 from Berkshire to Windsor, the balance is maintained, New Haven host counties are cut to eight, average travel distance is reduced to 136 miles (still high but less than Fairfield), Berkshire host counties are increased to five, and Berkshire average travel distance is increased to 124 miles. However, this move would reduce the number of Berkshire residents hosted within the county boundaries to less than 20 percent. If Berkshire key workers are to be hosted in Berkshire, only 16,100 can be moved to Windsor County, VT.

The New Haven move can still be accomplished by limiting the Berkshire move to 16,100 and moving in addition 6,000 of the original Middlesex assignment to Windsor. Since Windsor is already a host county for Middlesex, the number of host counties is not increased nor is the maximum travel distance. The average distance is increased to about the average for the planning area.

As another example, note in Table 24 that the maximum travel distance for the area is 256 miles for Hampshire County, MA to Franklin County, NY, and the maxima for Hartford and Tolland Counties are 254 miles. To reduce these maxima, Hampshire must be moved back from Franklin County, NY, and the other two must be moved back from Clinton County, NY. The Hampshire maximum can be reduced to 214 miles by moving 10,800 people from Franklin to Clinton County. The Hartford and Tolland distances can be reduced by moving 34,300 people from Clinton County, NY back to Addison County, VT, where some Hartford people already are assigned. This leaves space for 23,500 people in Clinton County after the Hampshire people are accommodated. Hence, this number are moved to Clinton County, NY from the Hampden assignment to Addison County. The Hampden maximum does not increase since there already are Hampden people assigned to Clinton. The Hampden average relocation distance will increase, but it is still below the area average. There remain 10,800 too many in Addison County and the same number too few in Franklin County, NY. To adjust, 10,800 from the Hampshire assignment to Addison are moved to Essex County, NY, and an equal number of the Berkshire assignment to Essex are moved to Franklin, where there is already a Berkshire assignment. The average relocation distances for Hampshire and Berkshire Counties will increase, but they are still below the area average.

It can be seen that considerable adjustment of the details of an allocation can be made once it is arrayed as the result of application of the 20 percent slice method. In the example, other options are evident but it is unlikely that the area maximum can be reduced below the 250 miles resulting from the Fairfield County assignment. This is, however, a reasonable area maximum. It should be noted that the maximum relocation distance inferred from a general allocation of the type described in Chapter 4 would be 321 miles, the distance along the flow from Fairfield County, CT to Franklin County, NY as there is no direct way to determine the specific assignments of the risk counties. (The average distance estimated from a general allocation will be only a few miles greater than the area average from a detailed allocation.)

How far to take this kind of final adjustment is a matter of judgment on the part of the planner and civil preparedness officials. Usually, it will be found that after several obvious and valuable adjustments, the law of diminishing returns will set in and further improvements will prove marginal or will create more problems than are corrected. At this stage, it is preferable to explore some of the alternatives discussed below.

Policy Alternatives

The 20 percent slice method of doing a detailed allocation within a planning area is simply a routine procedure for obtaining a reasonably equitable balance among the competing risk counties in terms of average and maximum relocation distances by highway while preserving close-in hosting locations for key worker commuting. Many policy considerations can be handled as case-by-case adjustments to the resulting allocation. For example, it is probably unwise in most instances to treat a county with a small risk population like all other risk counties, dividing a few thousand people into five or more portions and distributing them over the countryside. The only example of this situation in the western New England planning area is Franklin County, NY, with a risk population of 1,536. It turns out that these people are hosted within the county because there is insufficient competition for space from other risk counties. But if this were not the case, they should probably be hosted there anyway, either by advance assignment or as an adjustment of the detailed allocation. Better examples exist in the eastern New England planning area. For instance, the 3,000 or so people on Nantucket Island are at blast risk. Wherever they are moved, they should be assigned to one location. Also, it is probably advisable to consider whether they might be better protected by shelter on the island. Another example is Cape Code (Barnstable County), which has much hosting capacity and a risk population of less than 20,000. Since Cape Cod is an invaluable hosting location for key workers in the Boston-Providence area, it is best to follow the 20 percent slice method initially and then see what the effect on commuting distances would be if the Barnstable risk population was hosted entirely within the county. A comparison is likely to demonstrate that the latter policy has little adverse effect and much to recommend it in detailed planning.

In addition to case-by-case policy considerations, there are more general policy applications that can be reflected in a detailed allocation. One such policy has to do with a risk county's rights to use of the hosting space that may exist within its boundaries. This may be a political consideration, particularly in peacetime planning. A good approach is to alter the allocation to give each risk county prior rights to its own host capacity--beyond the first 20 percent--and to compare the result with the pure 20 percent slice allocation. Table 25 shows this allocation for the western New England planning area. In the first few moves of the allocation, each risk county with hosting space is assigned all or as much of its host capacity as it needs for its risk population. Thus, Fairfield County, CT uses all of the host capacity within it and has more risk population to be allocated. Litchfield County, on the other hand, houses all of its risk population within the county and has excess capacity. This is done for each county that appears both as a risk and host county. Next, those risk counties that do not have space assigned for the 20 percent commute slice are

Table 25

EXAMPLE ALLOCATION WORKSHEET GIVING RISK COUNTY
PRIOR RIGHTS TO ITS OWN HOST CAPACITY

		Risk Counties													
		Fairfield CT	New Haven CT	Middlesex CT	Litchfield CT	Hartford CT	Tolland CT	Hampden MA	Hampshire MA	Berkshire MA	Chittenden VT	Clinton NY	Franklin NY	St. Lawrence NY	
Risk Population - -		750.3	744.9	71.3	94.3	815.4	79.2	456.1	80.3	80.4	83.1	45.0	1.5	25.9	Proof
20 Percent Slice --		150.1	149.0	14.3	18.9	163.1	15.8	91.2	16.1	16.1	16.6	9.0	0.3	5.2	Total
Host Counties	**Capacity**														
Fairfield CT	212.5	212.5													212.5
Litchfield CT	249.1		149.0	5.8	94.3										249.1
Hartford CT	6.5					6.5									6.5
Hampden MA	15.0							15.0							15.0
Hampshire MA	218.3			8.5		129.5			80.3						218.3
Berkshire MA	344.8	87.7	149.0	14.3			2.0	11.4		80.4					344.8
Franklin MA	296.0					190.2	29.6	76.2							296.0
Bennington VT	146.4	66.6						79.8							146.4
Windham VT	165.4	83.5	81.9												165.4
Washington NY	263.6		67.1	14.3		163.1	15.8	3.3							263.6
Rutland VT	263.2	150.1	25.2					87.9							263.2
Windsor VT	220.4		123.8	14.3		82.3									220.4
Addison VT	121.3					80.8	15.8	24.7							121.3
Essex NY	173.2	150.1				23.3									173.2
Washington VT	238.3		149.0	14.3		8.8		66.5							238.3
Chittenden VT	80.2										80.2				80.2
Clinton NY	139.8					94.8						45.0			139.8
Grand Isle VT	17.9					17.9									17.9
Franklin NY	212.0					18.2	15.8	91.2			2.9		1.5		129.6
St. Lawrence NY	430.7													25.9	25.9
Proof Total		750.5	745.0	71.5	94.3	815.5	79.0	456.0	80.3	80.4	83.1	45.0	1.5	25.9	
Distance-Average		138	144	136	18	136	153	140	10	22	13	10	16	15	
-Maximum		250	233	213	18	296	296	274	10	22	105	10	16	15	
-Commute		21	43	50	18	45	61								

assigned the needed space as nearby as possible. Thereafter, counties that were initially allocated more than a 20 percent slice are brought into the allocation with a slice remainder. Thus, Fairfield County was initially allocated 212,500 spaces within its boundaries. After the key workers were allocated for the other counties, Fairfield was allocated 87,700 spaces in the nearest available county, Berkshire, MA, the amount being that necessary to complete its second 20 percent slice. As can be seen from Table 25, the principal result of this policy change is to increase the maximum relocation distance for Hartford and Tolland Counties to 296 miles and increase that for Hampden County to 274 miles. The average travel distances are also increased somewhat but commuting is still practicable. In some other planning areas, such as eastern New England and northern New Jersey, the result would have been to make commuting to some risk areas virtually impossible. In any event, the advantages and disadvantages of the policy change can be discussed by decision-makers with full awareness of the consequences by comparing the detailed allocations.

As another example of the use of a detailed allocation to explore a policy issue has to do with the way hosting space is allocated in the 20 percent slice method. Setting aside the first slice, which is for key workers and dependents, the remaining slices are successively allocated to counties that are some distance apart. Therefore, emergency information to the public would need to advise the residents of some part of the risk area to go to a not-too-distant host county and the residents of another part to go to a county much farther away. This may be perceived as a problem of internal equity and credibility. The alternative, of course, is to "clump" the allocation beyond the first 20 percent slice, beginning with the county most distant from the hosting area. Table 26 shows such an allocation for the western New England planning area. In this allocation, the risk counties are assigned commuting space as in the original allocation. Then, the remaining risk population of Fairfield County is assigned to the nearest remaining space, New Haven follows and so on down the risk county listing, allocating a single 80 percent slice for each county in turn to complete the allocation. Thus, Fairfield County hosts its critical industry and government population within its own borders and sends the remainder to Hampshire, Berkshire, and Franklin Counties in Massachusetts. New Haven County sends its key workers to Fairfield and Litchfield Counties as before, and its general public shares Franklin, MA with Fairfield, CT, fills Bennington and Windham, VT, and partially fills Washington County, NY. The remainder of the clumping process is clear in Table 26.

A comparison of the results of this allocation with the 20 percent slice method shown in Table 24 shows that there is no change for the outlying risk areas--Chittenden, Vermont, and the New York counties. Otherwise, maximum travel distances are reduced by 25 to 50 miles, the largest being 232 miles for Hampden County, MA. The average relocation distance is also reduced for Fairfield and New Haven Counties, those that get first choice. Elsewhere, average relocation distances are

Table 26

EXAMPLE ALLOCATION WORKSHEET SHOWING HOW
20 PERCENT SLICES CAN BE "CLUMPED"

		Risk Counties													
		Fairfield CT	New Haven CT	Middlesex CT	Litchfield CT	Hartford CT	Tolland CT	Hampden MA	Hampshire MA	Berkshire MA	Chittenden VT	Clinton NY	Franklin NY	St. Lawrence NY	
Risk Population - -		750.3	744.9	71.3	94.3	815.4	79.2	456.1	80.3	80.4	83.1	45.0	1.5	25.9	Proof
20 Percent Slice --		150.1	149.0	14.3	18.9	163.1	15.8	91.2	16.1	16.1	16.6	9.0	0.3	5.2	Total
Host Counties	Capacity														
Fairfield CT	212.5	150.1	62.4												212.5
Litchfield CT	249.1		86.6	14.3	18.9	129.3									249.1
Hartford CT	6.5					6.5									6.5
Hampden MA	15.0							15.0							15.0
Hampshire MA	218.3	82.9				27.3	15.8	76.2	16.1						218.3
Berkshire MA	344.8	328.7								16.1					344.8
Franklin MA	296.0	188.6	107.4												296.0
Bennington VT	146.4		146.4												146.4
Windham VT	165.4		165.4												165.4
Washington NY	263.6		176.7	57.0	29.9										263.6
Rutland VT	263.2				45.5	217.7									263.2
Windsor VT	220.4					220.4									220.4
Addison VT	121.3					121.3									121.3
Essex NY	173.2							173.2							173.2
Washington VT	238.3					92.9	63.4	82.0							238.3
Chittenden VT	80.2							63.6			16.6				80.2
Clinton NY	139.8							28.2	64.2	38.4		9.0			139.8
Grand Isle VT	17.9							17.9							17.9
Franklin NY	212.0									25.9	66.5	36.0	1.5		130.9
St. Lawrence NY	430.7													25.9	25.9
Proof Total		750.3	744.9	71.3	94.3	815.4	79.2	456.1	80.3	80.4	83.1	45.0	1.5	25.9	
Distance-Average		88	125	140	118	141	166	161	173	185	86	49	16	15	
-Maximum		115	168	165	149	197	197	232	214	227	105	59	16	15	
-Commute		21	36	39	18	31	42	17	10	22	10	10	16	15	

increased significantly. There is a reduction, generally, in the number of host counties assigned to a given risk county, the maximum being seven for Hartford and Hampden Counties. On balance, the clumping allocation might be considered the best for western New England and should certainly be presented for consideration by decision-makers. In planning areas involving large cities, such as New York, Philadelphia, and Boston, clumping will result in some risk counties being forced to go much farther, both on average and at a maximum, than other counties in the same risk area. Thus, both methods may have applications in various planning areas.

Transportation Alternatives

The detailed allocation procedure presumes that relocation is to be accomplished by highway transportation. Highway distances are used in the choice of host counties, relocation flow along major highways is the underlying concept, and the goal of minimizing relocation distance is related to the problems of highway travel. This orientation is reasonable since even in the large cities, most residents will relocate by highway vehicles, either first autos or buses and trucks. The detailed allocation can be made more consistent with the transportation analysis, however, if restrictions and movement by non-highway modes of travel are incorporated into the allocation highway capacity.

Capacity information gained by cordon analysis or similar analysis of the highway system can be used to influence the allocation of risk populations to host counties. This modification is especially important where there are severe limitations on movement into certain key host areas. No crucial example can be found in the western New England planning area. St. Lawrence County, NY, it will be noted, has hosting capacity for over 400,000 persons at a ratio of 5 to 1. At most, there are three two-lane, two-way rural highways leading into the county from western New England. If this restriction were important, the capacity of these roads, in terms of population moved over them during the movement period, should be substituted for the hosting capacity to assure that no more are assigned in the allocation than can be handled by the roads. In this case, however, St. Lawrence County is too distant to be allocated any but its own risk population.

A more important example occurs in eastern New England where the capacity of the highways into Maine is found to be substantially less than the ostensible hosting capacity of the State. In this case, it is important to reduce the hosting capacity to match, starting with the most remote counties so as to continue to minimize travel distances. In general, then, it is appropriate to evaluate the highway capacity analysis in each planning area to determine if restrictions should be made in the hosting capacity of certain host counties. This is best done in conjunction with the evaluation of non-highway mode travel discussed below. In some cases, movement restrictions may force a modification of the boundaries of the planning areas. For example, highway

capacity restrictions into the State of Maine may suggest that an additional county in Vermont be transferred from the western planning area to the eastern area to balance the hosting resources.

In most planning areas, those incorporating a large city, it is also important to account for the population to be relocated by non-highway modes. This is most readily accomplished by doing the detailed allocation in two stages. First, those who are to be transported by air, rail, or water are allocated on an allocation worksheet similar to Table 19. The numbers of people traveling by each mode are determined from the final transportation analysis. These must be assigned to appropriate risk counties served by the departure airports, rail terminals, and the like. Care should be exercised not to allocate to a risk county more than 80 percent of the portion of the risk population not having access to first autos. (It can be assumed that 20 percent of the carless population will be associated with critical industry and government.) The non-highway risk population for each risk county can be entered on the worksheet just below the 20 percent slice. If more than one non-highway mode is to be used by a given risk county, it is useful to enter the separate figures so that mode capacities are preserved.

Next, host counties that could be served by busing relocatees from arrival airports, rail stations, etc. should be identified. In the case of air travel, emphasis should be placed on the most remote airports and host counties, since distance is of no consequence and using these counties will be beneficial to the other travel distances. The capacity of each arrival airport can be allocated among the most suitable counties and entered in the body of the table. For rail transport, counties along the rail routes should be identified where off-loading can occur, and the rail capacity should be allocated with some consideration of highway accessibility. If water transportation has been incorporated in the transportation planning, a similar allocation should be made.

When the allocation of non-highway modes is complete, proof totals should be made. The column totals should equal the risk-county populations moving by non-highway mode. The row totals should be less than the hosting capacity of the affected host counties and should add to the total population moving by non-highway mode.

A second allocation worksheet should now be used for the highway allocation. The risk population of each affected risk county should be reduced by the amount moved by non-highway mode so that it represents only those traveling by auto, bus, or truck. Similarly, the hosting capacity of affected host counties must be reduced by the amount already assigned to persons traveling by non-highway mode. A running allocation should be made with the revised risk and host numbers for the highway

allocation. Note that if substantial numbers of people are moved by non-highway modes beyond highway bottlenecks, it may not be necessary to reduce hosting capacity as described earlier. This, indeed, is what happens in Maine where the air and rail movement compensates for the limited highway capacity at the border.

Note to Chapter 8

1. Planners may find it more helpful to flowchart the procedures outlined in Chapter 8, rather than to develop allocations by following the text step by step.

9. DOCUMENTATION OF PLANNING PROCESS

The concluding effort for the State/Regional planning team is the recording of the results and of the work that was done in producing them. From time to time it may appear necessary to modify or update the crisis relocation plan. When this occurs, the team who produced the plan may not be available to work on the changes for any of a number of reasons. And when considering changes in a plan, it is well to know why the plan was drawn as it was in the first place. Therefore, leaving a clear-cut record of what was done and of the alternatives considered must be the final step.

The Planning Report

This essential element of the documentation should record what was done in each step of the analysis. The body of the report should be a chronological account of the planning process beginning with the input data package and the initiation conferences. The work sheets, maps, and other data, together with a description of alternative policies regarding allocations considered, should be recorded in an appendix. The rationale for the final allocations should be in the body of the report.

One section of the report should be devoted to each stage of the planning process. This discussion should record the alternatives that were considered and the rationale for the selection of those to be implemented in the plan. Each of these sections should be supported by an appendix listing conferences, data sources and pertinent data, and work sheets developed in the planning.

Utilization of Results

The results of the analyses described herein are prerequisites to crisis relocation planning in highly urbanized areas and should be included in the Part I and Part II data packages as appropriate.

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